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CONCORD INSTRUMENT
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MODEL 7005A
DIGITAL MULTIMETER

SYSTRON DONNER

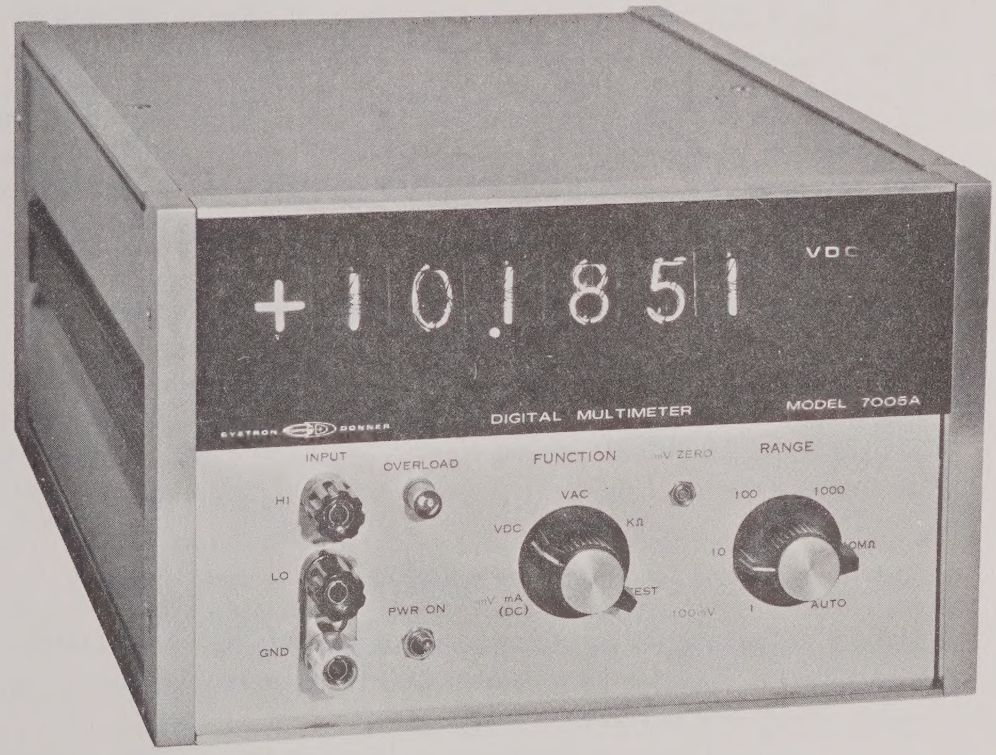
R.A. Clapper Rm-132

Concord Instrument Division

INSTRUCTION MANUAL

Electroglas

910



CONCORD INSTRUMENT
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MODEL 7005A
DIGITAL MULTIMETER

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SYSTRON DONNER CORPORATION

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Every Systron Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way or fails to operate, a claim should immediately be filed with the transportation company.

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ADDENDUM
MODEL 7005A

The Model 7005A Digital Multimeter is similar to the Model 7005 described in this manual with the following exceptions:

1. Specifications:

DC VOLTS
Range: ±1.00000 V, ±10.0000 V, ±100.000 V and ±1000.00 V.
Overrange: 20% on all ranges except 10% on 1000 volt range (±1100.00 V, max.)
Resolution: 10 µV (1 µV with Option 07).
Polarity: Automatic.
Input Impedance: >10,000 MΩ on 1 and 10 volt ranges; 10 MΩ on 100 and 1000 volt ranges.
Accuracy (23°C ±1°C):
±0.005% rdg. ±0.003% f.s. for 24 hours.
±0.01% rdg. ±0.004% f.s. for 3 months.
Temperature Stability: (±0.0008% rdg. ±0.0005% f.s.)/°C.
Full Scale Step Response (to 0.01%): 200 msec, typical; 400 msec, worst case.
Normal Mode Rejection: >80 dB from 59 Hz and up; >60 from 49 Hz to 59 Hz.
Common Mode Rejection: >120 dB at DC; >100 dB from 49 Hz to 440 Hz.

DC MILLIVOLTS (Option 07)
Range: ±100.000 mV plus 20% overrange (protected to ±300 volts).
Resolution: 1 µV.
Polarity: Automatic.
Input Impedance: 1000 MΩ.
Accuracy (23°C ±1°C):
Better than ±0.01% rdg. ±0.01% f.s. for 3 months.
Full Scale Step Response: Same as DC VOLTS.
Normal and Common Mode Noise Rejection: Same as DC VOLTS.

DC CURRENT (Option 04)
Ranges: ±1.00000 mA, ±10.0000 mA, ±100.000 mA, and ±1000.00 mA.
Overrange: 20% on all ranges (protected to ±2 A).
Resolution: 10 nA.
Polarity: Automatic.
Accuracy (23°C ±1°C): ±0.1% rdg. ±0.01% f.s. for 3 months.
Full Scale Step Response: Same as DC VOLTS.

AC VOLTS - 100 kHz (Option 02)
Ranges: 1.00000 V, 10.0000 V, 100.000 V and 1000.00 V.
Overrange: 20% on all ranges except 1000 volts.
Maximum Input: 750 V rms up to 10 kHz decreasing to 350 V rms at 100 kHz.
Resolution: 10 µV.

Input Impedance: 1 MΩ shunted by 50 pF (150 pF with Option 08).
Accuracy (23°C ±1°C) for 3 months:
±0.1% rdg. ±0.02% f.s. - 30 Hz to 100 kHz.
Full Scale Step Response (to 0.1%): 1 sec, typical; 3 sec, maximum.

AC VOLTS - 20 kHz (Option 06)
Ranges: 1.00000 V, 10.0000 V, 100.000 V and 1000.00 V.
Overrange: 20% on all ranges except 1000 volts.
Maximum Input: 750 V rms up to 10 kHz decreasing to 500 V rms at 20 kHz.
Resolution: 10 µV.
Input Impedance: 1 MΩ shunted by 50 pF (150 pF with Option 08).
Accuracy (23°C ±1°C) for 3 months:
±0.1% rdg. ±0.02% f.s. - 50 Hz to 20 kHz.
Full Scale Step Response (to 0.1%): 1 sec, typical; 3 sec, maximum.

RESISTANCE (Option 03)

Range	Resolution	Current thru Rx
1.00000 kΩ	10 milliohms	1 mA
10.0000 kΩ	100 milliohms	1 mA
100.000 kΩ	1 ohm	100 µA
1000.00 kΩ	10 ohms	10 µA
10000.0 kΩ	100 ohms	1 µA

Overrange: 20% on all ranges.
Accuracy (23°C ±1°C) for 3 months):
±0.01% rdg. ±0.015% f.s. - 1 kΩ range; ±0.01% rdg. ±0.005% f.s. - all other ranges.
Full Scale Step Response (to 0.1%): 1 sec worst case on 1, 10 and 100 kΩ ranges; 3 sec worst case on 1000 kΩ range; 10 sec worst case on 10,000 kΩ range.
Protection: Up to 100 volts may be applied to any range without damage.

GENERAL
Measurement Rate: 5 readings per second on DC, current,and resistance; 1 reading per second on AC.
Input Circuit: Fully floating with 500 volt isolation to ground.
Range Selection: Manual by front panel control. All function autoranging available (see OPTIONS).
Readout: Five full digits plus overrange digit. Automatically positioned decimal point for all functions. Polarity indicator. Function annunciator. Overload light. Readout storage for non-blinking display.
Kickback Noise: Less than 1 mV pk to source (when measured with 1 megohm impedance, 5 kHz bandwidth scope).
Operating Temperature Range: 0 to 50°C.
Dimensions: 5-1/4" H x 8-3/8" W x 13" D. Half rack size. Portable package includes carrying handle. Rack mountable (see ACCESSORIES).
Weight (with Options): 17 lbs. (7.8 kg) net; 20 lbs. (9 kg) shipping.

Power: 115/230 V (±10%), 48 to 62 Hz. 40 watts maximum.

OPTIONS (in addition to those described in above specifications)
Autoranging (Option 01): Provides automatic range selection for all selected functions.
Digital Outputs (Option 05): Provides BCD outputs and recorder control signals.

a) Outputs (digits, range, polarity, overload flag, and function).
Code: 1-2-4-8.
Logic: Binary "1" = +25 (±5) volts, 100 kΩ source.
Binary "0" = 0 (+0.5) volts, 10 mA sink.

b) Print Command: 0 to +18 volt pulse at end of each measurement cycle.

c) Inhibit Input: +15 volt level (min.) inhibits new measurement cycle.

Digital outputs are compatible with both discrete component and integrated circuit interface.

2. Final Assembly parts list changes:

Ref.	Description	SD Part No.
B1	Fan Assembly	B39460
F1	Fuse, .5 A, 3 AG, S.B.	F0012
J1	Line Filter	A31331-4-1
S2	Switch, Tog., SPDT	S0397
S3	Wiring Ass'y, Range Switch	B37038
S4	Wiring Ass'y, Function Switch	B37040
T1	Transformer Preparation	C37003
XF1	Fuse Holder	X0034
	Bracket, Filter, Air	B39391
	Filter, Air	B39410

3. Drawings Included:

Model 7005A Interconnect Schematic (2 sheets)	D37459A

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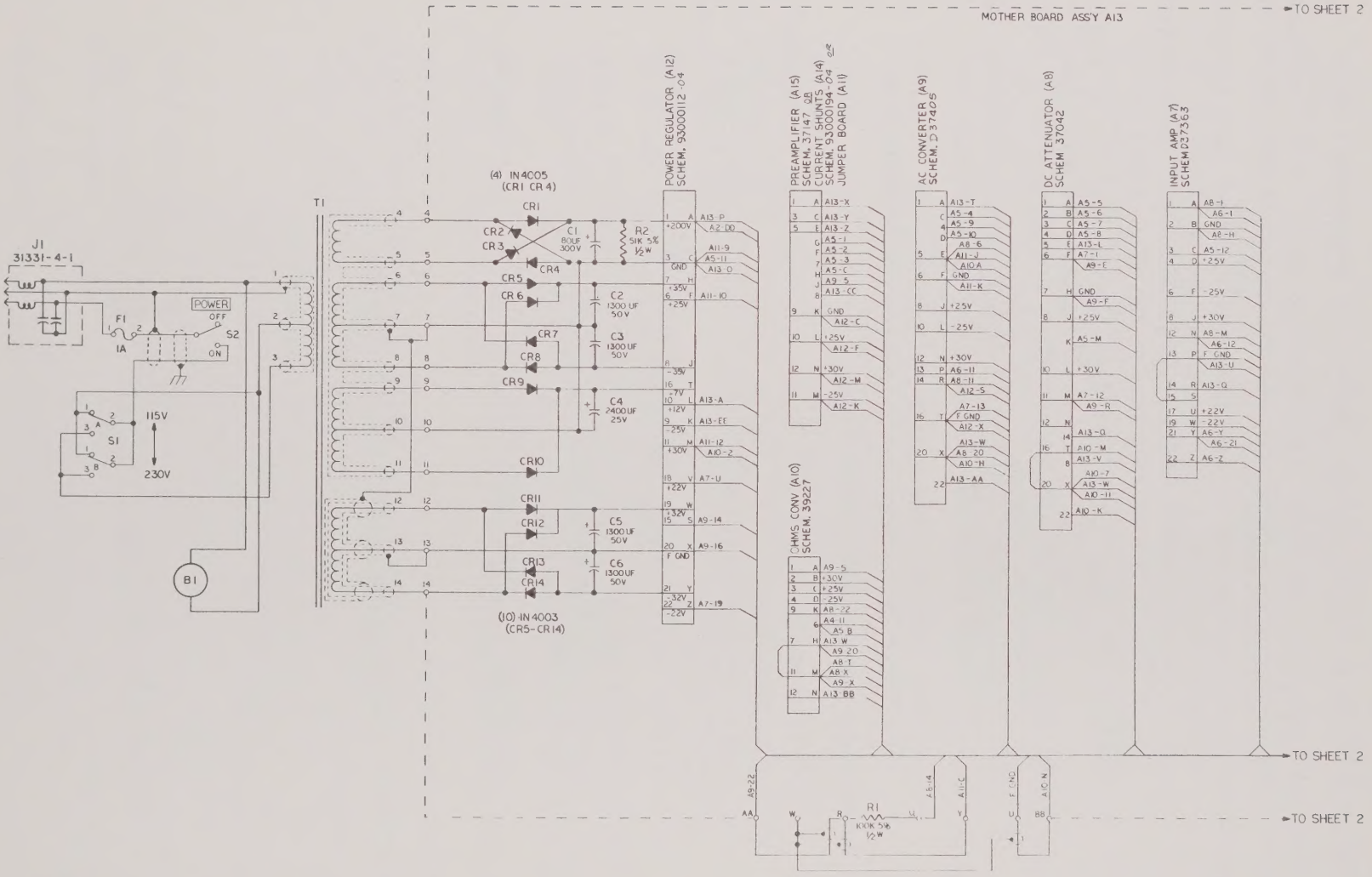

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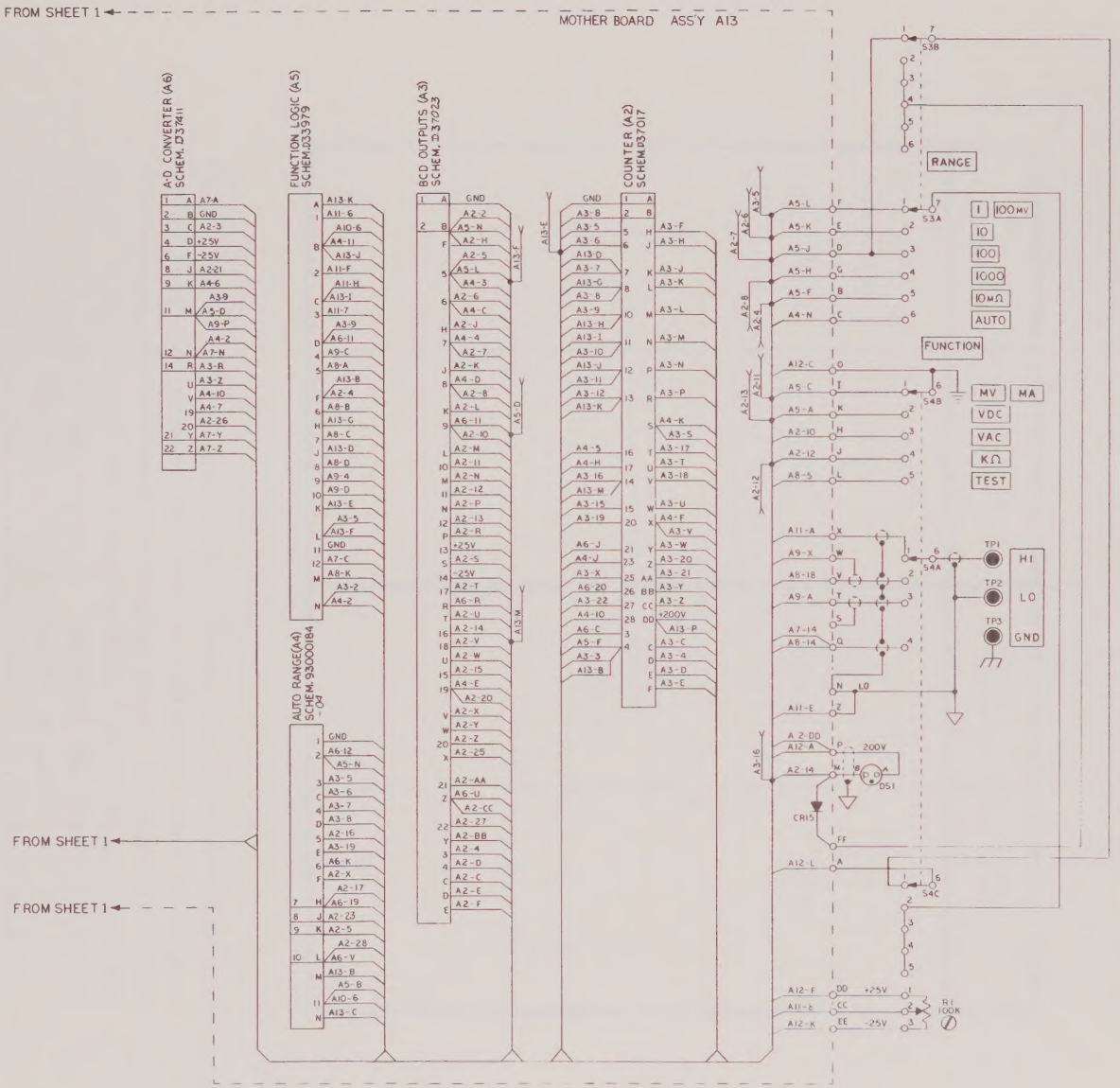

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CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Systron-Donner Model 7005 Digital Multimeter provides a new standard of price/performance characteristics for full 5 digit digital multimeters. The Model 7005 is the ideal instrument for those applications where extended range, resolution, and accuracy are required. The following standard features and specifications describe this unique design and versatility.

1.2 STANDARD FEATURES

The following features are standard in the 7005 Digital Multimeter:

Full Range Measurement:

The basic unit provides four ranges of DC voltage measurement from 1 volt full scale to 1000 volts full scale. Resolution is 0.001% of full scale which provides a basic sensitivity of 10 μ volts on the 1 volt full scale range. A sixth readout digit provides for 20% overrange capability.

High Input Impedance

Incorrect readings normally associated with input loading are virtually eliminated with the Model 7005. With an input impedance of greater than 10,000 megohms on both the 1 and 10 volt ranges, sources with an output resistance as high as 100 Ω may be measured with absolutely no loading error.

Built-in Noise Rejection:

The Model 7005 combines the built-in noise rejection characteristics of Dual Slope Integration together with a high-speed active filter to provide greater than 80 dB of normal mode noise rejection at all interfering frequencies from 59 Hz and above. In addition, the inherent noise rejection characteristics of the Dual Slope Integration technique provide significantly greater rejection "cusps" at interfering frequencies at all multiples of 20 Hz (incl. 60 Hz and 400 Hz).

Common mode rejection is greater than 120 dB at DC and greater than 100 dB at all frequencies from DC to 440 Hz, with up to 1 Ω source unbalance.

User Designed:

The Model 7005 has been designed to be as user-oriented as possible. Complete function selection is available from a single control with all range selection on a second control. The readout is large, clear and COMPLETE, including a lighted annunciator to tell the operator what is being displayed, ie, VDC, MVDC, kΩ, etc. There is no need to refer back to the function switch to determine what function is being displayed. A bright, flashing indicator immediately alerts the operator when an overload condition exists.

Total Field Expandability:

The basic DC measuring capacity of the Model 7005 may be expanded to a full multimeter AT ANY TIME by simple insertion of plug-in cards into prewired slots. The following options are available:

100 MILLIVOLT DC RANGE: Adds low level measuring range to extend the DC resolution to 1 microvolt.

AC VOLTS: Two "AC Volt" options are offered to allow full range measuring capability with frequency response to 20 kHz or 100 kHz.

RESISTANCE: Adds five ranges of ohms measurement with a basic resolution of 10 milliohms.

DC CURRENT: Provides built-in (no external shunts required) DC current measurement from 10 nanoamps to greater than 1 amp in four ranges.

ALL-FUNCTION AUTORANGE: Provides automatic range selection for all active functions.

DIGITAL OUTPUT: BCD output of all functions.

1.3 SPECIFICATIONS

Table 1-1 describes the Model 7005 Digital Multimeter Specifications:

Instrument should be warmed up for at least 1 hour to meet specifications.

TABLE 1-1. SPECIFICATIONS

DC VOLTS	Ranges:	±1.00000 V ±10.0000 V, ±100.000 V and ±1000.00 V.
	Overrange:	20% on all ranges except 10% on 1000 volt range (1100.00 V, max.).
	Resolution:	10 µV (1 µV with Option 07).
	Polarity:	Automatic.
	Input Impedance:	>10,000 MΩ on 1 and 10 volt ranges; 10 MΩ on 100 and 1000 volt ranges.
	Accuracy:	(23°C ± 1°C): ±0.005% rdg. ±0.003% f.s. for 24 hours. ±0.01% rdg. ±0.004% f.s. for 3 months.
	Full Scale Step Response:	(to 0.01%): 200 msec, typical; 400 msec, worst case.
	Normal Mode Rejection:	>80 dB from 59 Hz and up; >60dB from 49 Hz to 59 Hz.
	Common Mode Rejection:	>120 dB at DC; >100 dB from 49 Hz to 440 Hz.
AUTORANGING (OPTION 01)		Provides automatic range selection for all ranges of all selected functions.
AC VOLTS - 100 kHz (OPTION 02)	Ranges:	1.00000 V, 10.0000 V, 100.000 V and 1000.00 V.
	Overrange:	20% on all ranges except 1000 volts.
	Max. Input:	750 V rms up to 10 kHz decreasing to 350 V rms at 100 kHz.
	Resolution:	10 µV.
	Input Impedance:	1 MΩ shunted by 50 pF (150 pF with Option 08).
	Accuracy:	(23°C ±1°C) for 3 months.
	1, 10 and 100 V Ranges:	±0.1% rdg. ±0.02% f.s. - 50 Hz to 20 kHz ±0.2% rdg. ±0.04% f.s. - 20 kHz to 100 kHz
	1000 V Range:	±0.2% rdg. ±0.05% f.s. - 50 Hz to 20 kHz ±1.0% rdg. ±0.05% f.s. - 20 kHz to 100 kHz
	Full Scale Step Response:	(to 0.0%): 1 sec, typical; 3 sec, maximum.

TABLE 1-1. SPECIFICATIONS (Con't.)

RESISTANCE (OPTION 03)	Range:	1.00000 kΩ 10.0000 kΩ 100.000 kΩ 1000.00 kΩ 10000.0 kΩ
	Resolution:	10 milliohms 100 milliohms 1 ohm 10 ohms 100 ohms
	Current thru Rx	1 mA 1 mA 100 µA 10 µA 1 µA
	Overrange:	20% on all ranges:
	Accuracy:	(23°C ±1°C) for 3 months: ±0.01% rdg. ±0.015% f.s. - 1 kΩ range; ±0.01% rdg. ±0.005% f.s. - all other ranges.
	Full Scale Step Response	(to 0.01%): 1 sec worst case on 1, 10 and 100 kΩ ranges; 3 sec worst case on 1000 kΩ range; 10 sec worst case on 10,000 kΩ range.
	Protection:	Up to 100 volts may be applied to any range without damage.
DC CURRENT (OPTION 04)	Ranges:	±1.00000 mA, ±10.0000 mA, ±100.000 mA, and ±1000.00 mA.
	Overrange:	20% on all ranges (protected to ±2A).
	Resolution:	10 nA.
	Polarity:	Automatic
	Accuracy:	(23°C ±1°C): ±0.1% rdg. ±0.01% f.s. for 3 months.
	Full Scale Step Response:	Same as DC VOLTS.
DIGITAL OUTPUTS (OPTION 05)		Provides BCD outputs and recorder control signals. a) Outputs (digits, range, polarity, overload flag and function).
	Code:	1-2-4-8.
	Logic:	Binary "1" = +25 (±5) volts, 100 kΩ source. Binary "0" = 0 (+0.5) volts, 10 mA sink. b) Print Command: 0 to +18 volt pulse at end of each measurement cycle. c) Inhibit Input: +15 volt level (min.) inhibits new measurement cycle.
AC VOLTS - 20 kHz (OPTION 06)	Ranges:	1.00000 V, 10.0000 V, 100.000 V and 1000.00 V.
	Overrange:	20% on all ranges except 1000 volts.

TABLE 1-1. SPECIFICATIONS (Con't.)

AC VOLTS - 20 kHz (OPTION 06)	Max. Input:	750 V rms up to 10 kHz decreasing to 500 V rms at 20 kHz.
	Resolution:	10 µV.
	Input Impedance:	1 MΩ shunted by 50 pF (150 pF with Option 08).
	Accuracy:	(23°C ± 1°C) for 3 months: ±0.1% rdg. ±0.02% f.s. - 50 Hz to 10 kHz ±0.2% rdg. ±0.05% f.s. - 10 kHz to 20 kHz
	Full Scale Step Response:	(to 0.1%): 1 sec, typical; 3 sec maximum.
DC MILLIVOLTS (OPTION 07)	Range:	±100.000 mV plus 20% overrange (protected to ±300 volts).
	Resolution:	1 µV.
	Polarity:	Automatic.
	Input Impedance:	1000 MΩ.
	Accuracy:	(23°C ±1°C): Better than ±0.01% rdg ±0.01% fs for 3 months with front panel zero adjustment to compensate for ambient temperature variations.
	Full Scale Step Response:	Same as DC VOLTS.
	Normal and Common Mode Noise Rejection:	Same as DC VOLTS.
REAR SIGNAL INPUTS: (OPTION 08)		Allows input capability from rear panel.
GENERAL	Measurement Rate:	5 readings per second on DC, current and resistance; 1 reading per second on AC.
	Input Circuit:	Fully floating with 500 volt isolation to ground.
	Ranging	Manual by front panel control. All function autoranging available (see Options).
	Readout	Five full digits plus overrange digit. Automatically positioned decimal point for all functions. Polarity indicator. Function annunciator. Overload light. Readout storage for non-blinking display.
	Temperature	0 to 50°C.
	Dimensions	5 1/4" H x 8 3/8" W x 12" D. Half rack size. Portable package incl. carrying handle. Rack mountable (see Accessories).
	Weight	(with Options): 15 lbs. (6.8 kg) net; 18 lbs. (8.1 kg) shipping.
	Power	115/230 V (±10%), 48 to 440 Hz. 25 watts, max.

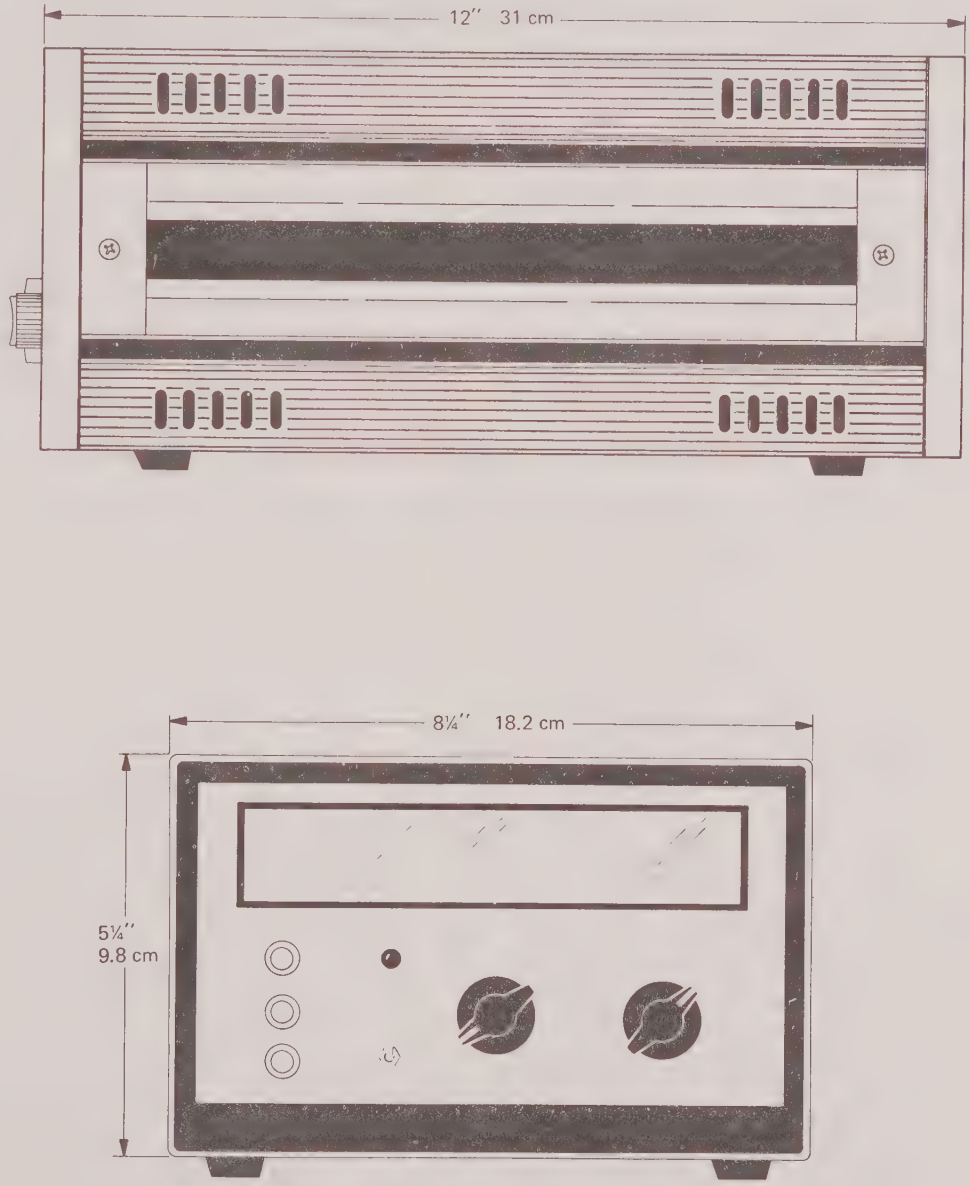


FIGURE 1-1. OVERALL DIMENSIONS, MODEL 7005

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

This section outlines procedures for inspection and initial installation of the Model 7005 and options. Reshipment instructions are included in case the instrument must be returned to Systron-Donner.

2.2 UNPACKING AND INSPECTION

Before accepting the instrument from the shipper, the packaged instrument should be inspected for external damage. Any sign of external damage must be noted by both customer and shipper, and should be called to the attention of the insurance investigator.

As soon as the equipment is unpacked, inspect the instrument for damage in shipment; check for scratches or dents and damaged knobs or connectors. If damage is noted, do not use the instrument unless instructed by the insuring agency.

2.3 POWER REQUIREMENTS

The Model 7005 is designed to operate from a 115/230 V, 50 to 400 Hz power source. Do not connect the instrument to a power source with incorrect voltage or inadequate current rating. The 115/230 V switch (located on the rear panel of the instrument directly above the power cord plug) should be set to the appropriate position, i.e., 115 for 115 V operation, 230 for 230 V operation.

The Model 7005 is equipped with a three-conductor power cable that grounds the instrument when the connector is plugged into an appropriate receptacle. To preserve this safety feature when operating with a two-contact outlet, use an adapter and connect the pigtail on the adapter to a suitable ground.

2.4 OPERATIONAL CHECK

The following preliminary operational check may be used to ensure that all components and circuits are in operating condition when the instrument is first operated. Refer to Figure 3-1 and 3-2 for location of operating controls. The procedure provides a quick check for proper functioning, but does not check specifications completely. Refer to page 5-1 for description of a complete performance check.

a) Check that 115/230 V switch is in correct position and then connect instrument to AC power source. Set PWR ON switch to ON. Check that readout panel lights up.

b) Set FUNCTION switch to TEST and RANGE switch to 1 V.

c) Check that readout indicates 0.10000 ±1 digit after a short warm-up period.

2.5 RESHIPMENT

When an instrument is damaged in shipment, do not return it to Systron-Donner without specific instructions from the insuring agency. Neither the customer nor Systron-Donner is required to assume responsibility for reshipment.

When a damaged instrument is to be returned to the factory for service or repair, contact your nearest Systron-Donner engineering representative for written permission to ship, shipping instructions and a shipping form.

2.6 INSTALLATION OF OPTIONS

The addition of each of the options for

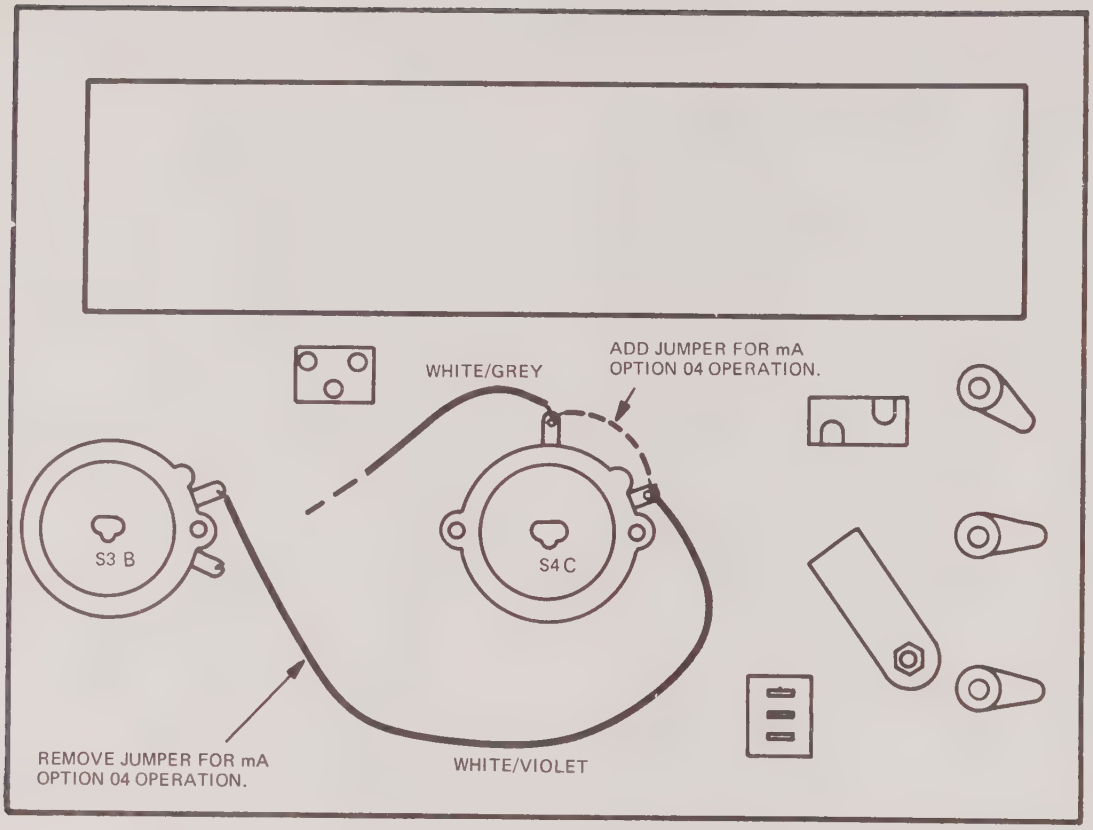


FIGURE 2-1. WIRING CHANGE FOR mA (OPTION 04) OPERATION

the Model 7005 with the exception of DC mA Option 04, BCD Option 05, and DC mV Option 07, requires the simple insertion of PC cards into the appropriate connectors on the instrument Mother Board. To install options, proceed as follows:

a) Remove all signal inputs to instrument and disconnect it from AC power source.

b) Remove top cover and Calibration cover to expose PC plug-in connections on mother board A13.

c) Insert option into appropriate connector and press firmly into place.

Option	Connector
01-Auto-Range	XA4
02-AC Volts	XA9
03-Resistance	XA10
06-AC Volts	XA9

d) Check readout accuracy following procedures given in Chapter 4 of the manual. Recalibrate as necessary using procedure in Section 4.6.

2.7 INSTALLATION OF DC MA OPTION 04

To install Option 04, carry out the following steps:

a) Remove all signal inputs to instrument and disconnect it from AC power source.

b) Remove top cover to expose mother board and PC plug-in connectors.

c) Insert Option 04 Assembly A13 into connector AX14.

d) Change wiring on switches S3 and S4 as shown in Figure 2-1. Remove unit readout shade and replace with shade supplied. Replace cover and perform DC current readout accuracy check given in Section 4.3.5 of this manual.

2.8 INSTALLATION OF BCD OPTION 05

To install Option 05, carry out the following steps:

a) Remove all signal inputs to instrument and disconnect it from AC power source.

b) Remove top and bottom covers from instrument.

c) Remove cover plate from "Accssories" slot on rear panel. Remove plug-in boards A4 and A5.

d) Consult operating instructions for Option 05 given in next paragraph and program board for desired mode of operation. The signals supplied by Option 05 are detailed in table 2-1.

e) From top of instrument, feed Option 05 connector J1 through hole in mother board A13. See figure 2-2.

f) Insert Option 05 board into mother board connector marked BCD A3.

g) Turn Model 7005 on its side and dress cable as shown in figure 2-2.

h) Feed Option 05 connector J1 through ACCESSORIES slot on rear panel and mount on panel using hardware supplied.

i) Replace plug-in boards A4 and A5 and replace top and bottom covers on instrument.

2.9 OPERATION - BCD OPTION 05

BCD Option 05 serves as a signal conditioner for the Fairchild CμL959 integrated circuit storage elements, changing their outputs to a level suitable for printer application. Option 05 also performs the necessary logic functions required for proper operation of the printer.

Cycle Mode*

The sampling rate of the cycle mode is determined by the Model 7005 measurement time and the printer readout time. With a full scale input, measurement time is approximately 150 msec. The printer will have a cycle time of approximately 200 msec. The maximum printout rate that can be expected with a full scale input is 4 to 6 per second.

To program cycle operation:

a) Connect a jumper between CYCLE contacts on Option 05 plug-in board.

b) Short PRINT terminal J1-21 to ground (Terminal J1-46). Opening this connection will halt the printer.

Remote Print*

To obtain remote control of print command:

a) Remove jumpers from Option 05 board CYCLE and HOLD terminals.

b) Provide closure for PRINT terminal J1-21 to ground (J1-46).

Hold Mode*

To obtain a hold mode of operation:

a) Connect a jumper between HOLD terminal on Option 05 board.

b) Provide a closure for PRINT terminal J1-21 to ground (J1-46). This initiates one print cycle after which the DVM readout will be held as long as J1-21 is grounded.

2.10 INSTALLATION OF DC MV OPTION 07

To install Option 07 in the Model 7005 proceed as follows:

a) Remove all signal inputs to the instrument and disconnect it from the AC power line.

b) Remove top cover to expose mother board and PC plug-in connectors.

c) Remove jumper Board Assembly A11.

d) Insert Option 07 assembly A15 into connector XA14. Press firmly into place.

e) Replace cover on instrument and reconnect to AC power line. Carry out accuracy check given in Section 4.3.2. If necessary, perform alignment procedure in Section 4.6.

2.11 INSTALLATION OF REAR INPUT OPTION 08

Factory installed.

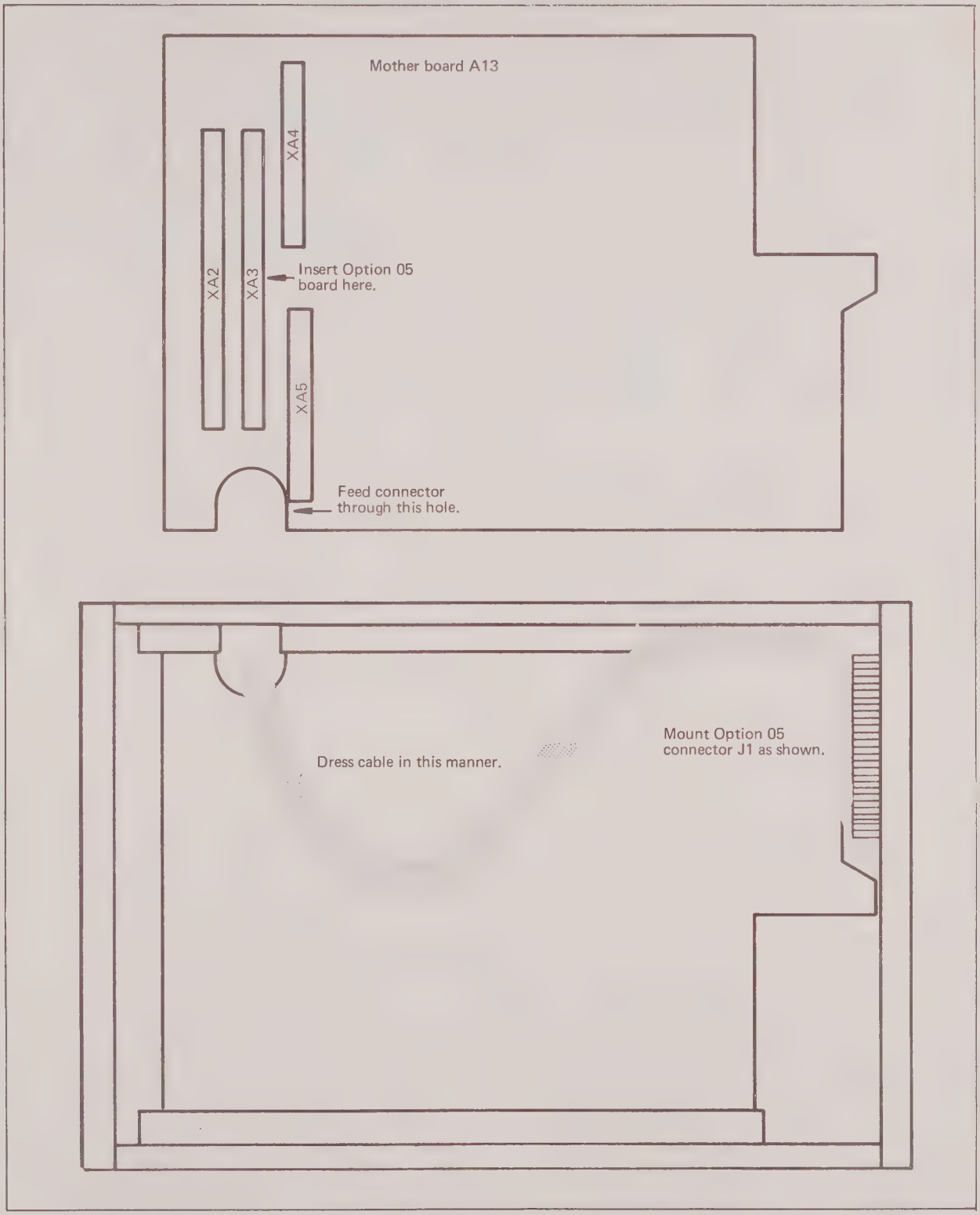


FIGURE 2-2. INSTALLATION INSTRUCTIONS, BCD OPTION 05

TABLE 2-1. INPUT AND OUTPUT SIGNALS, BCD OPTION 05

OUTPUT	CODE	J1 Pin Desig.
FUNCTION	1	17
	2	18
	4	42
	8	43
OVERLOAD	1	15
	2	16
	4	40
	8	41
POLARITY	1	19
	2	20
	4	44
	8	45
OVER-RANGE DIGIT (1.0)	1	13
	2	14
	4	38
	8	39
10,000's	1	11
	2	12
	4	36
	8	37
1000's	1	9
	2	10
	4	34
	8	35
100's	1	7
	2	8
	4	32
	8	33
10's	1	5
	2	6
	4	30
	8	31
UNITS	1	3
	2	4
	4	28
	8	29

REMARKS

LEVELS: "0" = +.25V ±.25V @ up to 5. mA sink; "1" = +25V, ±5V (300 µA may short circuit current source).

OUTPUT IMPEDANCE: A common emitter transistor switch with the collector connected to 25 V through a 100 kΩ resistor.

DECODER:

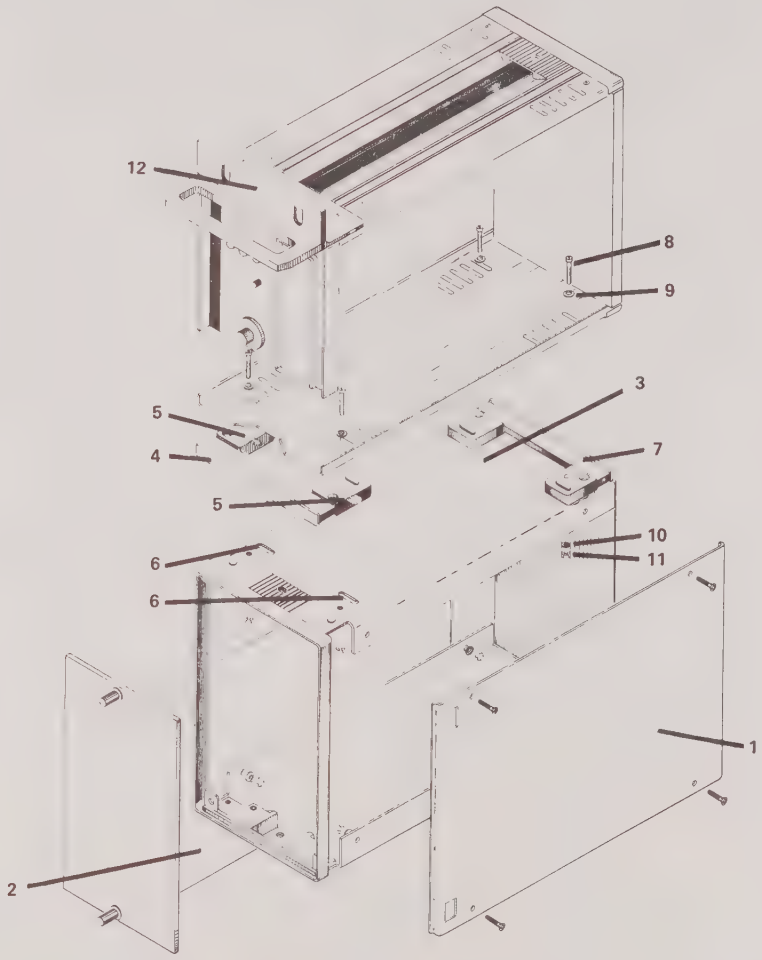
			8	4	2	1
FUNCTION	Test	=	0	0	0	0
	DC	=	0	0	0	1
	k	=	0	0	1	0
	AC	=	0	1	0	0
	mA	=	1	0	0	0
OVERLOAD	No Overload	=	0	0	0	0
	Overload	=	1	0	1	0
POLARITY	Negative (-)	=	1	0	1	1
	Positive (+)	=	1	0	1	0
	No polarity	=	1	0	1	0
DIGITS	0	=	0	0	0	0
	1	=	0	0	0	1
	2	=	0	0	1	0
	3	=	0	0	1	1
	4	=	0	1	0	0
	5	=	0	1	0	1
	6	=	0	1	1	0
	7	=	0	1	1	1
	8	=	1	0	0	0
	9	=	1	0	0	1
DECIMAL	xxxxxx	=	0	0	0	0
	xxxx.xx	=	0	0	0	1
	xxx.xxx	=	0	0	1	0
	xx.xxxx	=	0	0	1	1
	x.xxxxx	=	0	1	0	0

TABLE 2-1. INPUT AND OUTPUT SIGNALS, BCD OPTION 05 (Con't.)

Output	Code	J1 Pin Desig.	REMARKS
DECIMAL	1	1	
	2	2	
	4	26	
	8	27	
PRINT COMMAND		23	A pulse step from 0 to +18V (22V max, 15V min), 100 µsec ±50 µsec wide, rise time >1V per µsec. Output impedance is 100Ω.
INHIBIT		22	Inhibit sig. must be pos. pulse from printer to Option 05. A min. level of 15V is required. Input impedance is >27 kΩ.
+ REF		25	Reference levels (no load conditions): High (+) 17V ± 3V. Source impedance 4.7 kΩ ±20%.
- REF		24	Low (-) 5V ± 2V. Source impedance 3.9 kΩ ±20%.

CAUTION

The BCD output logic common is electrically connected to the Signal LO input. When operating the BCD outputs into a recording device whose electrical circuits are not isolated from ground, the signal LO input to the Model 7005 will become grounded. In this case do not attempt to measure floating/non-grounded signal sources or damage to the instruments will result.



A. Remove top cover (1) and bottom cover (2) from accessory box.

B. Place box on flat surface with side (3) facing upwards.

C. Place spacer (4) on side of box with protrusions (5) engaging in slots (6). Similarly fit other spacer (7).

D. Remove top and bottom covers from instrument.

E. Place instrument on top of spacers as shown.

F. Feed Allen head cap screw (8) with flat washer (9) through instrument, spacer and accessory box.

G. Install flat washer (10) and nut (11) to screw (8).

H. Similarly locate remainder of mounting hardware and tighten.

I. Replace covers on instrument and accessory box.

J. Install rack-mounting handles (12) to assembly following instructions detailed on page 2.

FIGURE 2-3b. INSTALLATION OF RACK MOUNT HARDWARE

CHAPTER 3
OPERATION

3.1 INTRODUCTION

The Model 7005 Digital Multimeter will measure DC voltage, and, with the inclusion of optional plug-in circuit boards, AC voltage, DC millivolts, DC current, and resistance. Ranging is manual, or automatic with the optional auto-ranging plug-in board. The full potential of this instrument can be realized only when the user has gained full appreciation of its operating principles and control functions. This section defines the functions of all controls and provides instructions to be observed when making measurements.

3.2 OPERATING CONTROLS

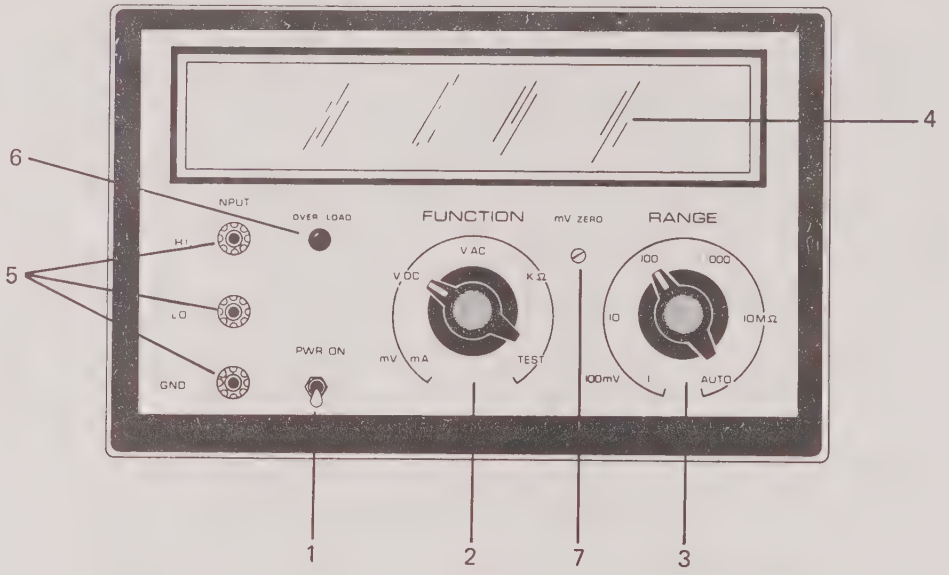
Figure 3-1 is a description of the front panel operating controls and Figure 3-2 depicts the rear panel controls and connectors.

3.3 OPERATING INSTRUCTIONS

NOTE

Before attempting measurements with the instrument, it is recommended that its operation be checked with the SELF CHECK procedure outlined in figure 3-3.

Figures 3-4 through 3-11 outline instructions for making measurements with the Model 7005. Each figure discusses a particular mode of operation. The number, or numbers associated with each control indicate the step in which the control is used.



1. PWR ON switch applies primary power to instrument.

2. FUNCTION switch:

   a. Connects instrument self-check feature into circuit when switched to TEST. Readout should be 0.10000 when RANGE switch is set to 1.

   b. Permits measurement of DC volts when switched to V DC.

   c. Permits measurement of resistance when switched to KΩ (an optional feature).

   d. Permits measurement of AC volts when switched to V AC (an optional feature).

   e. Permits measurement of DC current or millivolts when switched to mV/mA (optional features).

3. RANGE Control:

   a. Selects automatic ranging when switched to AUTO (an optional feature).

   b. Selects instrument readout range:

      1 . . . . . x.xxxxx
      100 mV . . xxx.xxx (Option 07)
      10 . . . . xx.xxxx
      100 . . . . xxx.xxx
      1000 . . . xxxx.xx
      10 MΩ . . . xxxx.x (KΩ mode only)

4. READOUT Panel presents:

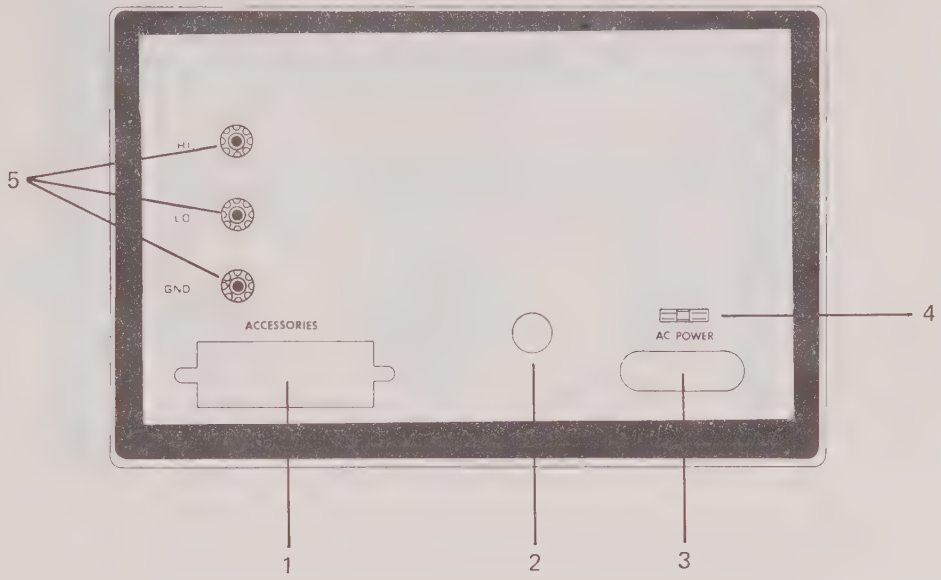
   Five digits of data (including one overrange digit), decimal point, function, and polarity.

5. HI, LO, and GND terminals are input connectors for floating or grounded sources.

6. OVERLOAD indicator flashes when amplitude of input signal exceeds range setting.

7. mV ZERO adjustment compensates for preamplifier drift due to temperature change.

FIGURE 3-1. FRONT PANEL DESCRIPTION



1. 50-pin Amphenol connector provides a 1-2-4-8 binary-coded-decimal output for use with external data logging equipment (an optional feature). (05)

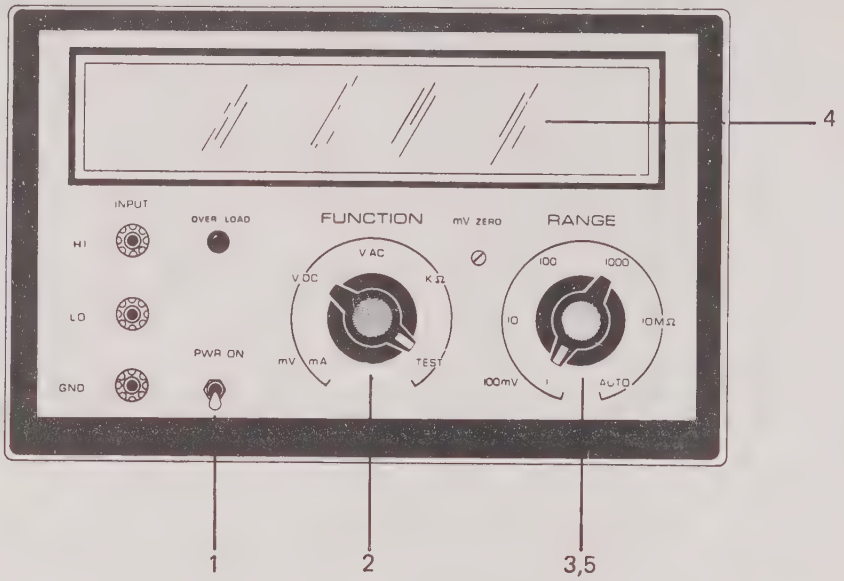
2. FUSE provides overload protection. Replacement value is ½ ampere, slow-blow for 115 V AC operation; ¼ ampere, slow-blow for 230 V AC.

3. 115 V/230 V switch permits selection of power input from either 115 V AC or 230 V AC source.

4. Input power connector for three wire power cable. Input can be 115 V/230 V, 50 to 400 Hz.

5. Rear signal input connectors provide input capability from the rear panel. (08)

FIGURE 3-2. REAR PANEL DESCRIPTION



1. Connect instrument to AC power source. Set PWR ON switch to ON.

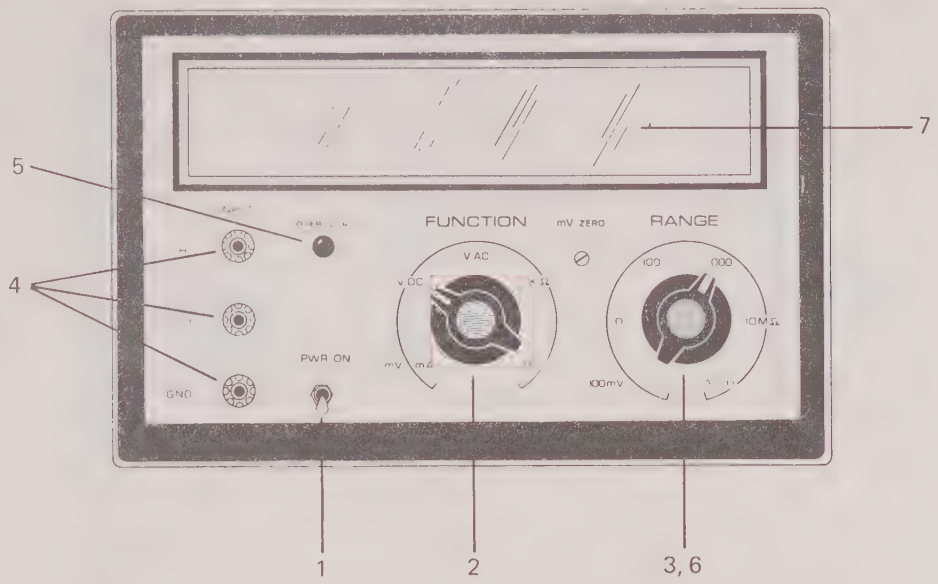
2. Set FUNCTION switch to TEST.

3. Set RANGE switch to 1.

4. Check that readout is 0.10000 ± 1 digit.

5. Set RANGE switch to 10, 100 and 1000. Readout should be 01.0000, 010.000 and 0100.0 respectively.

FIGURE 3-3. INSTRUMENT SELF CHECK



1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to V DC.
3. Set RANGE switch to 1000.
4. Connect HI, LO, and GND terminals to unknown DC voltage source. Voltage amplitude must be within 0 to 1000 V DC range.
5. If OVERLOAD indicator is flashing, input voltage is beyond measurement range of instrument. Disconnect instrument from voltage source.
6. Progressively select lower RANGE settings until correct range is reached.
7. Read voltage on display. Decimal point is correctly positioned. Measurement unit (V DC) and polarity are displayed.

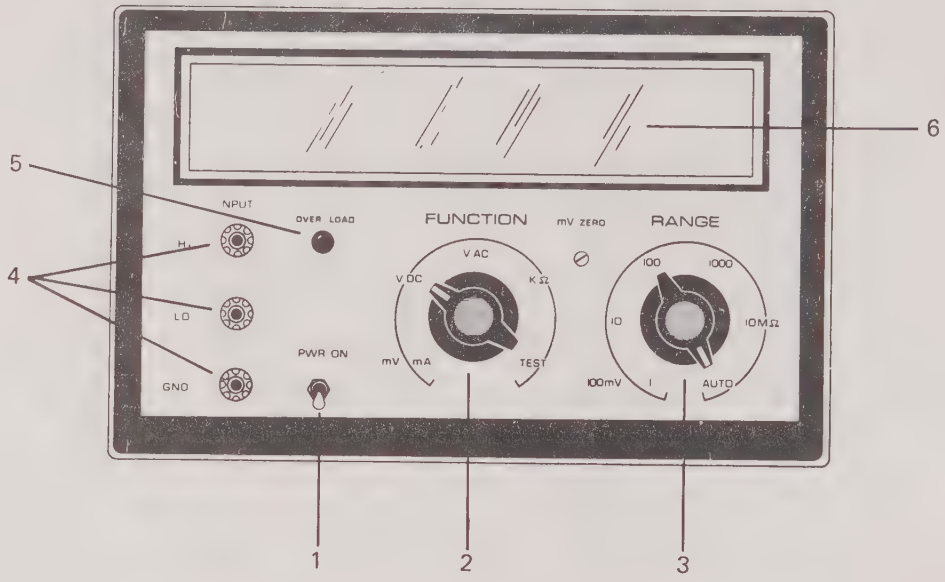
NOTE

The terminals must be used correctly to reduce ground loop currents to a minimum and achieve best measurement accuracy. When measuring a low level, high impedance source with its own ground, connect GND terminal to the source ground and the HI and LO terminals to the high and low outputs of the source. For all other measurements connect the GND and LO terminal to one measurement point and the HI terminal to the other.

CAUTION

THE MEASURING CIRCUIT IS FLOATED FROM THE CHASSIS GROUND OF THE INSTRUMENT. THE POTENTIAL APPLIED BETWEEN LO AND GND MUST NOT EXCEED 500 V OR DAMAGE TO THE INSTRUMENT MAY RESULT.

FIGURE 3-4. DC VOLTAGE MEASUREMENT, MANUAL RANGING



1. Connect instrument to AC power source. Set PWR ON switch to ON.

2. Set FUNCTION switch to V DC.

3. Set RANGE switch to AUTO.

4. Connect HI, LO, and GND terminals to unknown DC voltage source. Voltage amplitude must be within 0 to 1000 V DC range.

NOTE

The terminals must be used correctly to reduce ground loop currents to a minimum and achieve best measurement accuracy. When measuring a low level, high impedance source with its own ground, connect GND terminal to the source ground and the HI and LO terminals to the high and low outputs of the source. For all other measurements connect the GND and LO terminal to one measurement point and the HI terminal to the other.

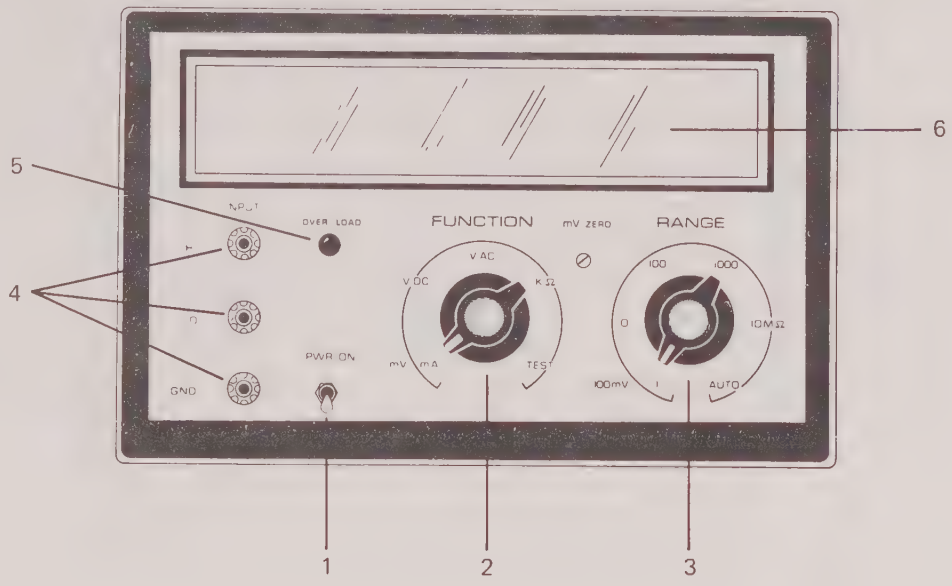
5. If OVERLOAD indicator is flashing, input voltage is beyond measurement range of instrument. Disconnect instrument from voltage source.

6. Read voltage on display. Decimal point is correctly positioned. Measurement unit (V DC) and polarity are displayed.

CAUTION

THE MEASURING CIRCUIT IS FLOATED FROM THE CHASSIS GROUND OF THE INSTRUMENT. THE POTENTIAL APPLIED BETWEEN LO AND GND MUST NOT EXCEED 500 V OR DAMAGE TO THE INSTRUMENT MAY RESULT.

FIGURE 3-5. DC VOLTAGE MEASUREMENT, AUTO RANGING



1. Connect instrument to AC power source. Set PWR ON switch to ON.

2. Set FUNCTION switch to mV.

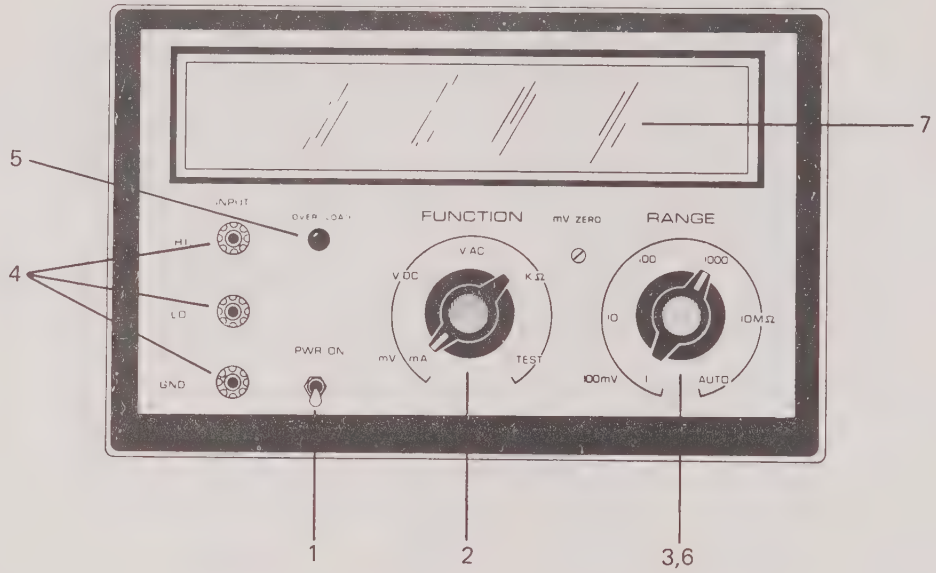
3. Set RANGE switch to 100 mV.

4. Connect HI, LO and GND terminals to unknown DC voltage source. Voltage amplitude must be within range 0 to ± 120.00 mV.

5. If OVERLOAD indicator is flashing, input voltage is beyond measurement range of instrument. Disconnect instrument from voltage source.

6. Read voltage on display. Decimal point is correctly positioned. Measurement unit (mV) and polarity are displayed.

FIGURE 3-6. DC mV MEASUREMENT

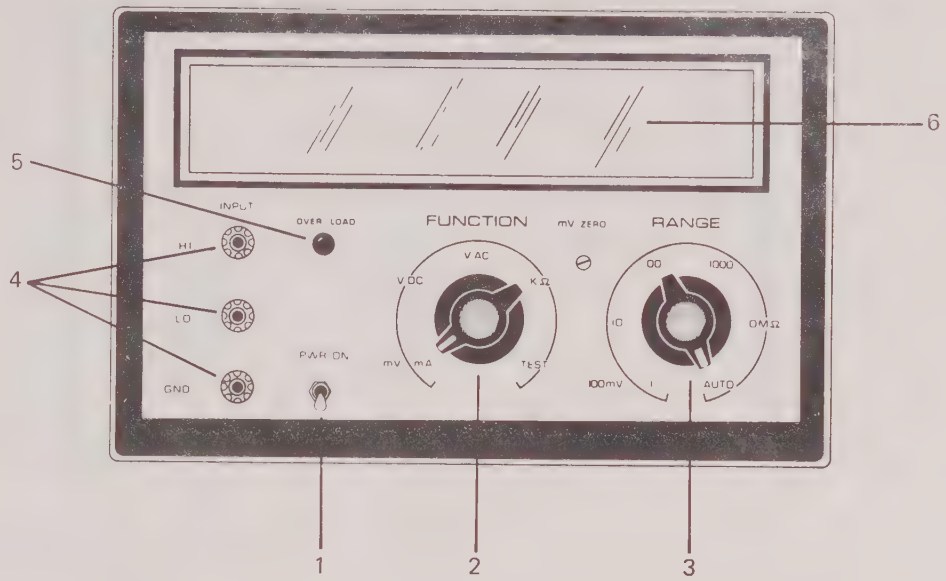


1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to MA DC.
3. Set RANGE switch to 1000.
4. Connect HI, LO, and GND terminals to DC current source.
5. If OVERLOAD indicator is flashing, input current is beyond measurement range of instrument. Disconnect from current source.
6. Progressively select lower RANGE settings until correct range is reached.
7. Read DC current on display. Decimal point is correctly positioned and measurement unit (MA DC) is displayed.

CAUTION

A MAXIMUM OF 2 AMPERES MAY BE APPLIED TO ANY RANGE WITHOUT DAMAGE.

FIGURE 3-7. DC CURRENT MEASUREMENT, MANUAL RANGING

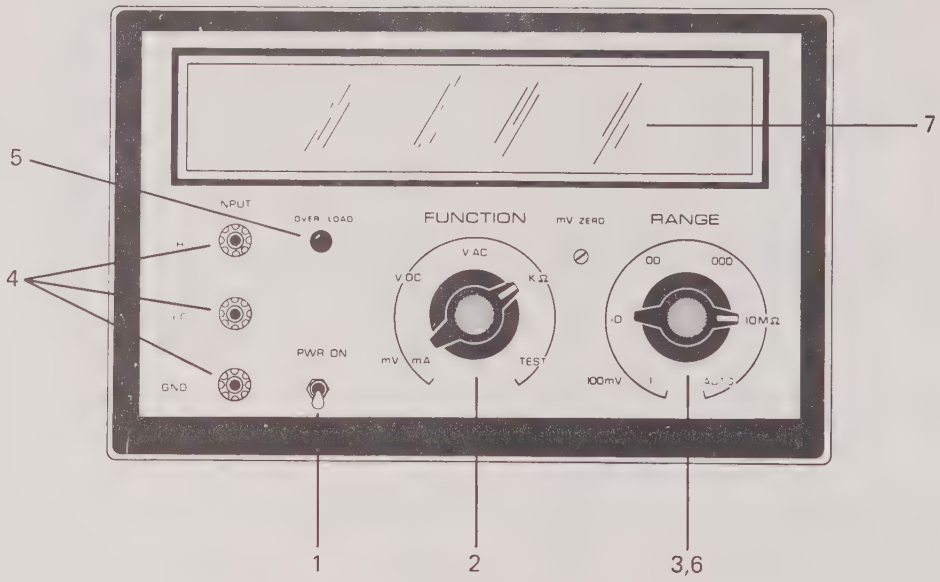


1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to MA DC.
3. Set RANGE switch to AUTO.
4. Connect HI, LO, and GND terminals to DC current source.
5. If OVERLOAD indicator is flashing, input current is beyond measurement range of instrument. Disconnect from current source.
6. Read DC current on display. Decimal point is correctly positioned and measurement unit (MA DC) is displayed.

CAUTION

A MAXIMUM OF 2 AMPERES MAY BE APPLIED TO ANY RANGE WITHOUT DAMAGE.

FIGURE 3-8. DC CURRENT MEASUREMENT, AUTORANGING

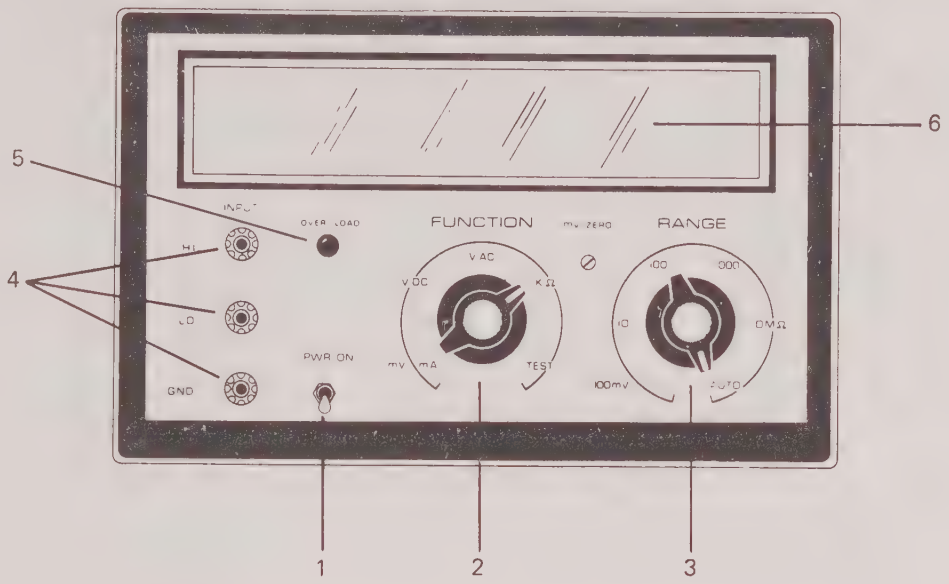


1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to KΩ.
3. Set RANGE switch to 10 MΩ.
4. Connect unknown resistance between HI and LO terminals.
5. If OVERLOAD indicator is flashing, value of resistance under test is beyond measurement range of instrument.
6. Progressively select lower RANGE settings until correct range is reached.
7. Read resistance on display. Decimal point is correctly positioned and measurement unit (KΩ) is displayed.

CAUTION

DO NOT CONNECT A CONSTANT VOLTAGE SOURCE TO THE INSTRUMENT WITH THE FUNCTION SWITCH IN THE KΩ POSITION. VOLTAGE IN EXCESS OF 100 V WILL DAMAGE THE INSTRUMENT.

FIGURE 3-9. RESISTANCE MEASUREMENT, MANUAL RANGING

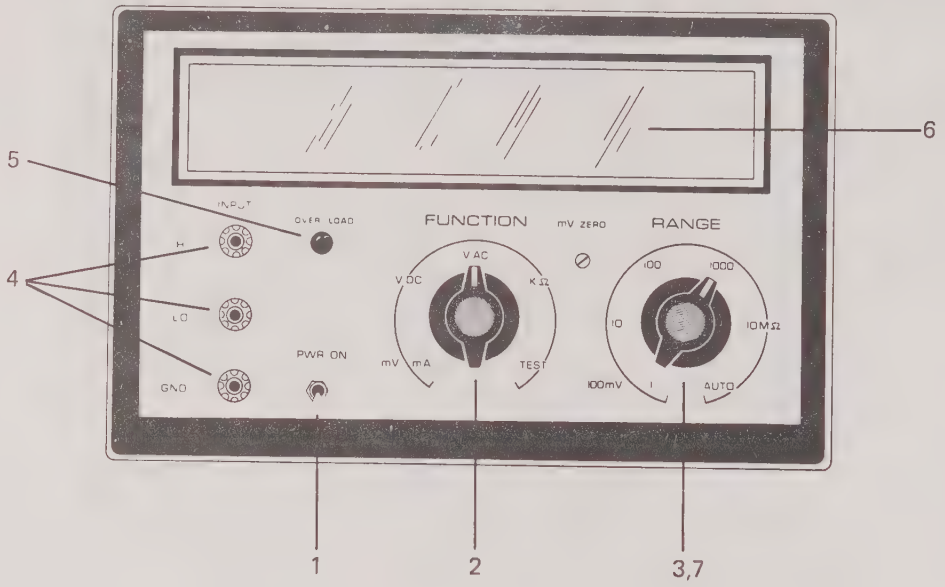


1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to KΩ.
3. Set RANGE switch to AUTO.
4. Connect unknown resistance between HI and LO terminals.
5. If OVERLOAD indicator is flashing, value of resistance under test is beyond measurement range of instrument.
6. Read resistance on display. Decimal point is correctly positioned and measurement unit (KΩ) is displayed.

CAUTION

DO NOT CONNECT A CONSTANT VOLTAGE SOURCE TO THE INSTRUMENT WITH THE FUNCTION SWITCH IN THE KΩ POSITION. VOLTAGE IN EXCESS OF 100 V WILL DAMAGE THE INSTRUMENT.

FIGURE 3-10. RESISTANCE MEASUREMENT, AUTO RANGING



1. Connect instrument to AC power source. Set PWR ON switch to ON.
2. Set FUNCTION switch to V AC.
3. Set RANGE switch to 1000.
4. Connect HI, LO, and GND terminals to AC voltage source.
5. If OVERLOAD indicator is flashing, input voltage is beyond measurement range of instrument. Disconnect from voltage source.
6. Read AC voltage on display. Decimal point is correctly positioned and measurement unit (V AC) is displayed.
7. Progressively select lower RANGE settings until correct range is reached.

CAUTION

MAXIMUM ALLOWABLE INPUT VOLTAGE IS FREQUENCY-DEPENDENT. DO NOT EXCEED LIMITS LISTED BELOW OR DAMAGE TO THE INSTRUMENT MAY RESULT.

Frequency	Maximum Input Voltage
50 Hz to 10 kHz	750 V
10 kHz to 30 kHz	500 V
30 kHz to 100 kHz	350 V

FIGURE 3-11. AC VOLTS MEASUREMENT, MANUAL RANGING

CHAPTER 4
MAINTENANCE AND CALIBRATION

4.1 INTRODUCTION

This section contains calibration, maintenance, and troubleshooting information for the Model 7005. Also included is a list of test equipment required for the procedures outlined in the section.

4.2 TEST EQUIPMENT REQUIRED

Table 4-1 lists the test equipment required for performance tests, troubleshooting, and adjustment of the instrument. If the recommended equipment is not available, equipment with equivalent specifications may be substituted.

In procedures that involve accurate DC voltage or resistance measurements, care must be taken to ensure consistent results. Working standards should be referred to primary standards on a regular basis. Particular care should be observed with resistance standards that are subject to long-term drift due to aging.

4.3 PERFORMANCE CHECK

The performance check outlined in the following paragraphs will verify the specifications of the Model 7005. It can be used upon receipt of a new instrument, for routine preventive maintenance, and following repair of the instrument. The Model 7005 under test may not have all of the measurement options. In this case, check only those modes pertinent to the unit under test.

During all of the performance checks the LO input should be connected to the chassis at the instrument.

4.3.1 DC Voltage Measurement Accuracy

To check the accuracy of DC voltage readout proceed as follows:

a) Make the following initial settings on Model 7005.

FUNCTION . . . . . VDC
RANGE 1
PWR ON . . . . . on
(for 1 hr min)

b) Set output of DC Voltage Standard to zero.

c) Connect HI and LO INPUT terminals on Model 7005 to positive (+) and negative (-) output terminals respectively on DC Voltage Standard.

d) Check readout at each Voltage Standard output setting listed in Table 4-2. In each case readout should be within tolerance given.

e) Reduce DC Voltage Standard output to zero and disconnect test equipment from Model 7005.

NOTE

If the instrument fails to meet the performance standards at any time, proceed to the appropriate calibration and alignment procedure to correct the malfunction.

Instrument should be operated for 1 hr. to reach stable temperature condition before calibration is performed.

TABLE 4-1. REQUIRED TEST EQUIPMENT

Instrument Type	Purpose	Critical Specifications	Recommended Instrument
DC Voltage Standard	DC voltage alignment and calibration.	Accuracy: ±0.001% Range: 0.1 µV to 1000V	Cohu ESI Model
Resistance Standard	Resistance alignment and calibration.	Accuracy: ±.005% Range: .01Ω to 1.1MΩ	RS925A
AC Voltage Source	Provide AC test voltage at low distortion.	Stability: ±0.02% Distortion: <0.05% Output: <ADJ to 1000V 50 Hz to 100 kHz	HP745A & HP746A
DC Current	Provide DC current for alignment and calibration.	Current Range: 0.1 µA to 1A Accuracy: ±0.02%	Fluke Model 382A
DC Current Meter	Measure DVM Offset Current.	Current Range: 10 pA to 1 mA Accuracy: ± 2%	HP Model 425A
Voltmeter	Power Supply Checks, Troubleshooting	Range: 1000V Accuracy: ±0.2% Input Resistance: 10MΩ	Systron-Donner Model 7000A
Oscilloscope	Ripple Measurements, Troubleshooting	Passband: DC to 300 kHz Sensitivity: 1 mV/cm	Tektronix 540 Series

TABLE 4-2. INITIAL DC VOLTAGE MEASUREMENT ACCURACY AT 23±1°C FOR 24 hrs.

7005 Function & Range	DC Voltage Standard Volts	7005 Readout Limits Maximum	Minimum
VDC 1	0.00000	±0.00003	±0.00003
	±0.30000	±0.30004	±0.29996
	±0.80000	±0.80007	±0.79993
	±1.10000	±1.10008	±1.09992
VDC 10	±00.0000	±00.0003	±00.0003
	±03.0000	±03.0004	±02.9996
	±08.0000	±08.0007	±07.9993
	±11.0000	±11.0008	±10.9992

TABLE 4-2. INITIAL DC VOLTAGE MEASUREMENT ACCURACY AT 23±1°C FOR 24 hrs. (Con't.)

7005 Function & Range	DC Voltage Standard Volts	7005 Readout Limits Maximum	Minimum
	±000.000	±000.003	±000.003
VDC	±030.000	±030.004	±029.996
100	±080.000	±080.007	±079.993
	±110.000	±110.008	±109.992
	±0000.00	±0000.03	±0000.03
VDC	±0300.00	±0300.04	±0299.96
1000	±0800.00	±0800.07	±0799.93
	±1000.00	±1000.08	±0999.92

4.3.2 DC mV Measurement Accuracy

To check accuracy of DC mV readout, proceed as follows:

a) Make the following initial settings on Model 7005.

FUNCTION . . . . . mV
RANGE . . . . . 100 mV
PWR ON . . . . . on
(for 1 hr min)

CAUTION

Do not apply voltages in excess of 300 V on the 100 mV range. Damage to the instrument may result.

b) Set output of DC Voltage Standard to zero.

c) Connect HI and LO terminals on Model 7005 to positive (+) and negative (-) output terminals respectively on DC Voltage Standard. Adjust front panel zero for 000.000 readout.

d) Check readout at each DC Voltage Standard output setting listed in Table 4-3. In each case readout should be within tolerance given.

e) When tests are complete, reduce DC Voltage Standard to zero and disconnect from Model 7005.

TABLE 4-3. DC VOLTAGE STANDARD OUTPUT SETTING

7005 Function & Range	DC Voltage Standard mV	7005 Readout Limits Maximum	Minimum
mV	000.000	±000.003	±000.003
100 mV	±001.000	±001.003	±000.997
	±010.000	±010.004	±009.996
	±100.000	±100.010	±099.990

4.3.3 Resistance Measurement Accuracy

To verify resistance readout accuracy, use the following procedure:

a) Make the following initial settings on Model 7005.

FUNCTION . . . . . kΩ
RANGE 1
PWR ON . . . . . on
(for 1 hr min)

b) Set standard resistance to 1 kΩ.

c) Connect HI and LO INPUT terminals on Model 7005 to output terminals on Resistance Standard. Use low resistance cables.

d) Check readout accuracy at each Resistance Standard setting listed in Table 4-4. In each case readout should be within tolerance given. On 1 kΩ range, input cables will add to resistance. Short at end of cables to determine cable error.

e) Disconnect Resistance Standard from Model 7005.

TABLE 4-4. INITIAL RESISTANCE MEASUREMENT ACCURACY CHECK AT 23±1°C

7005 Function & Range	Resistance Standard (kΩ)	7005 Readout Limits Maximum	Minimum
	0.00000	0.00015	0.00000
kΩ	0.25000	0.25018	0.24982
1	0.60000	0.60021	0.59979
	1.10000	1.10026	1.09974
	1.1000	01.1007	01.0993
kΩ	2.5000	02.5008	02.4992
10	6.0000	06.0011	05.9989
	11.0000	11.0016	10.9984
	11.000	011.007	010.993
kΩ	25.000	025.008	024.992
100	60.000	060.011	059.989
	110.000	110.016	109.984
	110.00	0110.07	0109.93
kΩ	250.00	0250.08	0249.92
1000	600.00	0600.11	0599.89
	1100.00	1100.16	1098.84
	1100.0	01100.7	01099.3
MΩ	2500.0	02500.8	02499.2
10	6000.0	0600011	0599989
	10000.0	1000015	0999985

4.3.4 AC Voltage Measurement Accuracy

Use the following procedure to verify readout accuracy. See Figure 4-1 for test setup.

a) Make the following initial settings on Model 7005.

FUNCTION . . . . . VAC
RANGE . . . . . 1 V
PWR ON . . . . . on
(for 1 hr min)

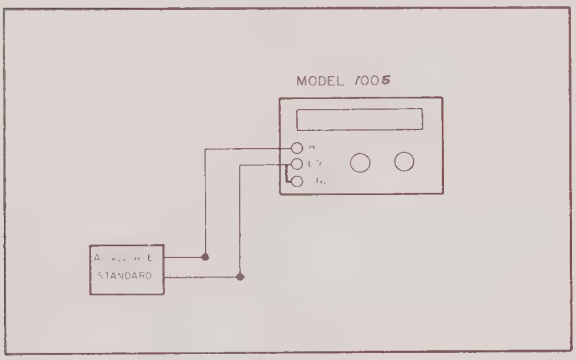


FIGURE 4-1. AC TEST SETUP

CAUTION

In the following steps do not exceed maximum input voltage ratings. Damage to the Model 7005 may result.

Freq. Range	Max. Input Voltage
50 Hz to 10 kHz	750 V
10 kHz to 30 kHz	500 V
30 kHz to 100 kHz	350 V

b) Connect HI and LO INPUT terminals on Model 7005 across output of AC Voltage Standard.

c) Check readout at each AC Voltage Standard level and frequency setting listed in Table 4-5. In each case readout should be within tolerance given.

d) At completion of tests, disconnect all test equipment.

TABLE 4-5. AC VOLTAGE MEASUREMENT ACCURACY AT 23±1°C

Range	Resolution	Frequency	Accuracy
1.00000 VAC full scale	10. uVAC	50 Hz to 20 kHz	±.1% Rdg. ±.02% FS
		20 kHz to 100 kHz	±.2% Rdg. ±.04% FS
10.0000 VAC full scale	100. uVAC	50 Hz to 20 kHz	±.1% Rdg. ±.02% FS
		20 kHz to 100 kHz	±.2% Rdg. ±.04% FS
100.000 VAC full scale	1. mVAC	50 Hz to 20 kHz	±.1% Rdg. ±.02% FS
		20 kHz to 100 kHz	±.2% Rdg. ±.04% FS
1000.00 VAC full scale	10 mVAC	50 Hz to 20 kHz	±.2% Rdg. ±.05% FS
		20 kHz to 100 kHz	±1.% Rdg. ±.05% FS

4.3.5 DC Current Measurement Accuracy

Use the following procedure to verify DC current readout accuracy:

a) Make the following initial settings on Model 7005

FUNCTION . . . . . MA DC
RANGE 1
PWR ON . . . . . on
(for 1 hr min)

CAUTION

Do not apply currents in excess of 2 amps to the Model 7005. Damage to the instrument may result.

b) Set current output from the DC Current Standard to zero. Connect Current Standard output terminals to HI and LO INPUT terminals on Model 7005.

c) Check accuracy at each setting of DC Current Standard listed in Table 4-6. In each case readout should be within tolerance given.

d) Disconnect Current Source from Model 7005.

TABLE 4-6. DC CURRENT MEASUREMENT ACCURACY AT 23±1°C

Range	Resolution	Accuracy *	Temperature Coefficient
1.00000 mADC	10. nADC	±.1% Rdg. ±.01% FS	(±.007% Rdg. ±.0008% FS)/°C
10.0000 mADC	100. nADC	±.1% Rdg. ±.01% FS	(±.007% Rdg. ±.0008% FS)/°C
100.000 mADC	1. uADC	±.1% Rdg. ±.01% FS	(±.007% Rdg. ±.0008% FS)/°C
1000.00 mADC	10. uADC	±.1% Rdg. ±.01% FS	(±.012% Rdg. ±.0008% FS)/°C

Shunt Resistance		
1. mADC Rdg	1 kΩ	1. VFS
10. mADC Rdg	100Ω	1. VFS
100. mADC Rdg	10Ω	1. VFS
1000. mADC Rdg	1Ω	1. VFS

*Long Term
(90 days at "reference" conditions)

4.3.6 Automatic Ranging

Check operation of the automatic ranging circuitry as follows:

a) Make following initial settings on Model 7005.

FUNCTION . . . . . VDC
RANGE . . . . . AUTO
PWR ON . . . . . on
(for 1 hr min)

b) Set output of DC Voltage Standard to zero.

c) Connect HI and LO INPUT terminals on Model 7005 to output terminals on DC Voltage Standard.

d) Set DC Voltage Standard to 1.1999 V. The Model 7005 should read on 1 V scale.

e) Set DC Voltage Standard to 1.2000 V. The Model 7005 readout should up-range to 10 V range.

f) Set DC Voltage Standard to 01.081 V. Instrument should remain in 10 V range.

g) Set DC Voltage Standard to 01.0790 V. Instrument should down-range to 1 V range.

h) Check remaining ranges using voltages given in Table 4-7. Note that instrument changes range at voltage levels listed.

TABLE 4-7. AUTO-RANGING LIMITS

Range	Up Min.	Up Max.	Down Min.	Down Max.
1	1.2000	1.2009	-	-
10	12.000	12.009	01.080	01.071
100	120.00	120.09	010.80	010.71
1000	-	-	0108.0	0107.1

4.3.7 Overload Indicator

To check operation of the OVERLOAD indicator use following procedure:

a) Make following initial settings on Model 7005.

FUNCTION . . . . . VDC
RANGE 1
PWR ON . . . . . on
(for 1 hr min)

b) Set output of DC Voltage Standard to zero.

c) Connect HI and LO INPUT terminals of Model 7005 to output terminals on DC Voltage Standard.

d) Increase Standard for readout of 1.1999. OVERLOAD indicator should NOT light.

e) Momentarily increase DC voltage to readout 1.2000. OVERLOAD indicator should start blinking. Decrease DC Voltage to zero.

f) Disconnect DC Voltage Standard from Model 7005.

4.4 PERIODIC MAINTENANCE

The Model 7005 requires a minimum of periodic maintenance. If maintenance is performed on a regular basis, the paragraphs below suggest a routine to follow.

a) Remove top and bottom covers from instrument. Inspect the chassis and mounted components for damage, signs of overheating, etc. Remove circuit boards and inspect for damage or evidence of component failure. Using low pressure dry compressed air, blow out any dust accumulation.

b) Rotate front panel controls through full range, noting any binding or rough action.

c) Following inspection wash all PC boards with freon and replace covers. Carry out performance check, and P.C. Board repair.

4.5 CALIBRATION PROCEDURE

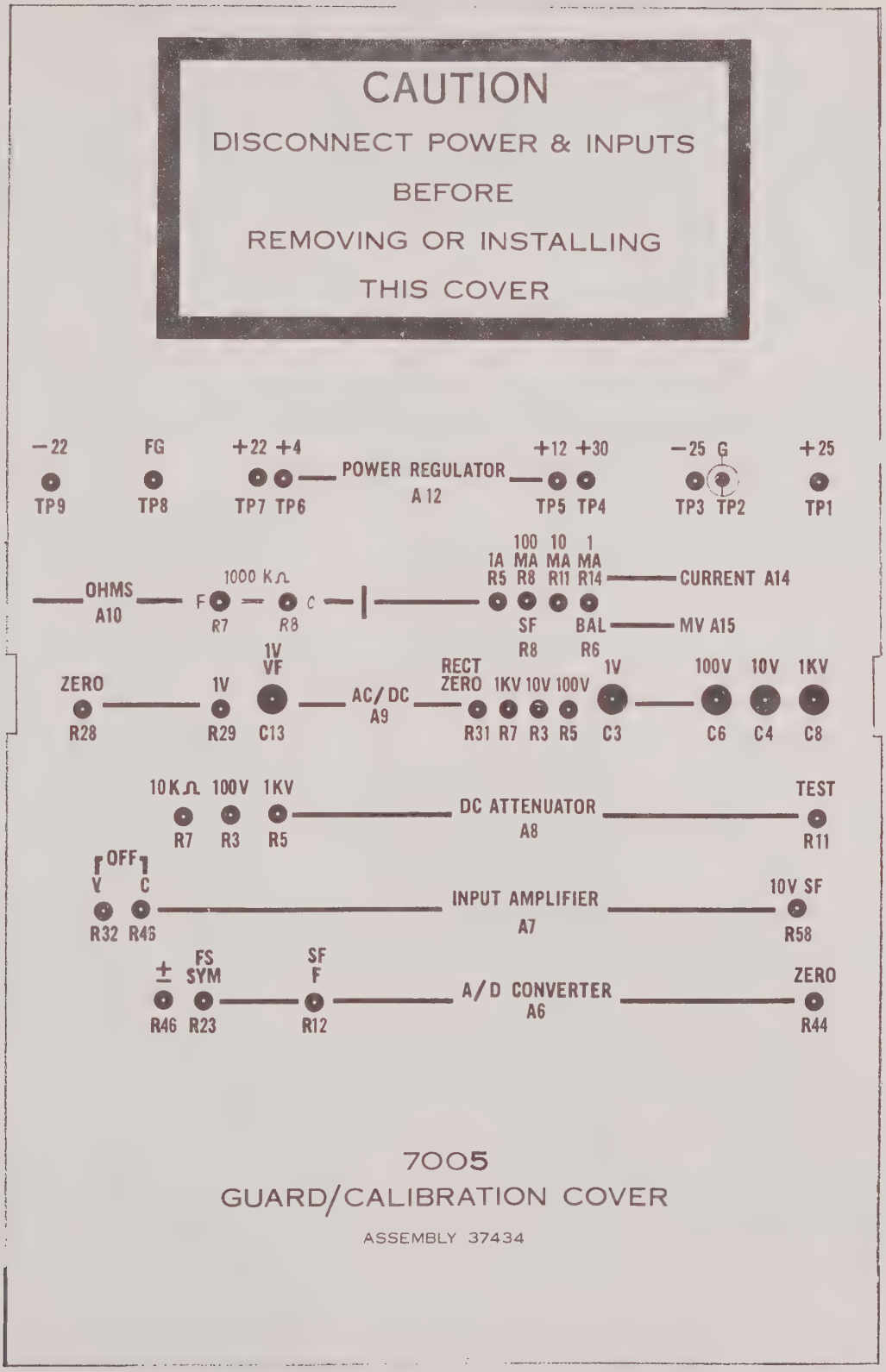
The calibration and alignment procedure that follows can be used after field installation of a measurement option, for routing preventive maintenance, and following repair. The multimeter may not have all options fitted. In this case, follow only those portions of the calibration procedure pertinent to the unit under test.

4.5.1 DC Power Supply Test & Calibration

On the rear panel, slide the 115/230 VAC switch to the 115V position. Check the fuse to see that the proper fuse was installed (1/2 amp Slo Blo). Turn on the power switch and proceed with DC voltage measurements in the following steps. Line voltage must be 115±5V rms, 60±1 Hz.

TABLE 4-8. DC POWER SUPPLY VOLTAGE MEASUREMENTS

Step No.	Between Test Points	Voltage Limits	Adjustments & Comments	Max. Ripple
1.	TP2 (GND) & TP-4 (+30V)	+28 to 40V	Non-regulated supply, no adjustments	≤800 mV pp
2.	TP2 (GND) & TP-5 (+12V)	+8 to 12V	Semi-regulated supply, no adjustments	≤280 mV pp
3.	TP2 (GND) & TP-3 (-25V)	-24.5 to 26.5V	Remove jumper across A12-R17 to increase voltage or remove jumper across A12-R16 to decrease volt.	≤14 mV pp
4.	TP4 (GND) & TP-1 (+25V)	+24.0 to 26.0V	No adjustment necessary.	≤14 mV pp
5.	TP2 (GND) & TP-6 (+4V)	+3.6 to 4.0V	Remove jumper across A12-R28 to increase voltage or remove jumper across Q12-R29 to decrease volt.	≤140 mV pp
6.	TP8 (F.G.) & TP-9 (-22V)	-22.5 to 25.5V	Remove jumper across Q12-R42 to increase voltage or remove jumper across Q12-R41 to decrease volt.	≤14 mV pp
7.	TP8 (F.G.) & TP7 (+22V)	+22.0 to 26.0V	No adjustments necessary.	≤14 mV pp
8.	A12-1 (+200V) & A12-3 (GND)	+170 to 230V	No adjustments	≤8 V pp
NOTE: Line current shall not exceed 250. mA @ 115 VAC				



7005

GUARD/CALIBRATION COVER

ASSEMBLY 37434

FIGURE 4-2. 7005 GUARD/CALIBRATION COVER ASSEMBLY 37434

4.6 FUNCTIONAL CALIBRATION PROCEDURE

The following calibration procedure is intended to be performed using the internal calibration cover after the machine has been operating for one hour without disturbance. Adjustments should be made only when the instrument is operated at an ambient temperature of 23 ± 1°C. Signal common should be tied to chassis ground to prevent entrance of uncontrolled common mode signals.

TABLE 4-9. CALIBRATION PROCEDURE

Calibration Step No.	Function	Range	Input	Adjustments
1	VDC	1	Short	Adjust A7-R32 (V off) for uncertain polarity indication.
2	VDC	1		With a pico ammeter between the Hi and Lo input terminals, adjust A7-R46 (C off) for <±20pA input current. Recheck steps 1 and 2.
3	VDC	1	Short	Set A6-R44 (zero ADJ) fully clockwise. Adjust A6-R46 (± ADJ) for minimum readout, then adjust to increase readout 30 counts.
4	VDC	1	Short	Adjust A6-R44 (zero ADJ) until readout just goes to zero.
5	VDC	1	±0.00010V	Readjust A6-R44 (zero ADJ) if necessary for a readout to ±0.00010V. Recheck steps 1, 2, and 5.
	NOTE: Before proceeding, repeat steps 4 and 5 until the offset current is less than ±20 pA and the symmetry is set.			
6	VDC	1	+1.00000 V	Set A6-R12, (F SF) to its center position. Adjust A6-R22 (C SF) for R0 of +1.00000 V ±10 counts. Adjust A6-R12 (F SF) to +1.00000 VDC.
7	VDC	1	-1.00000 V	Adjust A6-R23 (FS SYM) for R0 of -1.00000 V.
8				Recheck steps 2 thru 7.
9	VDC	10	Shorted	R0 should be +00.0000 ± 1 digit.
10	VDC	10	+10.0000 V	Adjust A7-R58 (10 V SF) for R0 of +10.0000 V.
11	VDC	10	±10.0000 V	Adjust S7-R58 (10 V SF) for best balance between ±10 V.

TABLE 4-9. CALIBRATION PROCEDURE (Con't)

Calibration Step No.	Function	Range	Input	Adjustments
12	VDC	100	Shorted	RO should be +000.000 ±1 digit.
13	VDC	100	+100.000 V	Adjust A8-R3 (100 V) for R0 of +100.000 V.
14	VDC	100	±100.000 V	Adjust R8-R3 (100 V) for best balance between ±100 V.
15	VDC	1000	Shorted	R0 should be +0000.00 ±1 digit.
16	VDC	1000	+1000.00 V	Adjust A8-R5 (1 kV) for R0 of +1000.00 V.
17	VDC	1000	-1000.00 V	Adjust A8-R5 (1 kV) for best balance between ±1000 V.
18	TEST	10	None Required	Adjust A8-R11 (TEST) for R0 of 01.0000
19	TEST	1000	1000.00 kΩ	Adjust A10-R8 (1000KΩ coarse) and A10-R7 (1000KΩ fine) to 1000.00KΩ.
20	k	100	100.000 kΩ	R0 should be 100.000 kΩ ± 3 digits.
21	k	10	10.0000 kΩ	Adjust A8-R7 (10 kΩ) for R0 of 10.0000 kΩ.
22	k	1	1.0000 kΩ	R0 should be 1.00000 kΩ ±12 counts*.
23	k	1	0.00000 kΩ	R0 should be 0.00000 kΩ ±12 counts*.
24	mADC	1	Shorted	R0 should be 0.00000 ±1 count
25	mADC	1	+1.00000 mA	Adjust A14-R14 (1 mA) for R0 of +1.00000 mA.
26	mADC	10	+10.0000 mA	Adjust A14-R11 (10 mA) for R0 of +10.0000 mA.
27	mADC	100	+100.000 mA	Adjust A14-R8 (100 mA) for R0 of +100.000 mA.
28	mADC	1000	+1000.00 mA	Adjust A14-R5 (1 A) for R0 of +1000.00 mA.
29	mVDC	100 mVDC	Shorted	Adjust front panel zero to center position.
30	mVDC	100 mVDC		Adjust A15-R6 (mV BAL) for R0 of +000.000 mVDC. With a pico-ammeter between the Hi & Lo input terminals, measure the input current. It should be less than ±50 pADC

*Resistance of test leads must be considered here.

R0 = Readout

TABLE 4-9. CALIBRATION PROCEDURE (Con't)

Calibration Step No.	Function	Range	Input	Adjustments
31	mVDC	100 mVDC	+100.000 mVDC	Adjust A15-R8 (mV SF) for R0 of +100.000 mVDC.
32	mVDC	100 mVDC	-100.000 mVDC	Adjust A15-R8 (mV SF) for best balance between ±100 mV.
33	VAC	1	.0001 VAC @ 400 Hz	Adjust A9-R45 (0) for R0 of 0.00010 VAC.
34	VAC	1	.0002 VAC @ 400 Hz	Readout should increase, if not, readjust A9-R45 (0) to other side and repeat 33 and 34.
35	VAC	1	1.00000 VAC @ 400 Hz	Adjust A9-R6 (1 V) for R0 of 9.99995 VAC.
36	VAC	1	1.00000 VAC @ 50 kHz	Adjust A9-C12 (1 V) for R0 of 0.99925 VAC.
37	VAC	10	10.0000 VAC	Adjust A9-R8 (10 V) for R0 of 09.9995 VAC.
38	VAC	10	10.0000 VAC @ 50 kHz	Adjust A9-C16 (10 V) for R0 of 09.9925 VAC.
NOTE: If there is insufficient range on C12 or C16, C13 and C14 (Cxxx's) may be adjusted as needed.				
39	VAC	100	100.000 VAC @ 400 Hz	Adjust A9-R2 (100 V) for R0 of 1000.000 VAC
40	VAC	100		Adjust A9-C4 (100 V) to midpoint.
41	VAC	100	100.000 VAC @ 10 kHz	Adjust A9-C8 (100 V) for R0 of 100.000 VAC
42	VAC	100	100.000 VAC @ 50 kHz	Not reading.
43	VAC	100	100.000 VAC @ 10 kHz	Adjust A9-C4 (100 V) for R0 error of 4 times, but in opposite direction, from error noted in step 41.
NOTE: If there is insufficient range on C8, C6 (Cxxx) may be adjusted as needed.				
44				Repeat 41 and 42 as necessary.
45				Recheck all AC adjustments, as there may be slight interaction.

CHAPTER 5
FUNCTIONAL DESCRIPTION

5.1 INTRODUCTION

This section discusses the operating principles of the Systron-Donner Model 7005 Digital Multimeter. Specific circuit descriptions will appear in Chapter 6 along with assemblies, schematics and parts list.

5.2 BASIC OPERATING PRINCIPLES

Figure 5-1 is a block diagram of the multimeter. In order to describe the basic measurement technique, assume that the DC volts mode (VDC) of operation has been selected. (This function is chosen because the DC measurement circuitry is common to all modes of operation; the additional conversion required for optional measurement of resistance, DC current and AC voltage is described in later paragraphs.) The DC input voltage is coupled via DC attenuator A8 to input amplifier A7. This unit is a solid-state chopper-stabilized operational amplifier with a floating power supply and is connected to produce an output current directly proportional to the amplitude of the input voltage. Ranging resistors in the attenuator and the amplifier transconductance resistance are selected by the front panel RANGE switch (or automatically by optional auto-ranging assembly A4) to provide the same current level for each of the four input voltage ranges. The output of the amplifier is connected to a current rectifier on assembly A6 which gives an output current that is equal to the input current in magnitude, but is of negative polarity, regardless of the input current polarity. The current rectifier serves two purposes: it supplies a current proportional to the voltage being measured to integrating capacitor A6C5 and it senses the polarity of the input voltage for display on the readout polarity indicator.

A measurement cycle consists of two parts. See Figure 5-2. The first portion begins when the start circuit (a free-running multivibrator) generates a start pulse. The leading edge, (t_1 on Figure 5-2) resets the decade counting units to 000000 and the trailing edge (t_2) sets the input flip-flop. The input flip-flop "IN" output closes solid-state switch A6Q7, coupling the output of the current rectifier to integrating capacitor A6C5. Simultaneously, the input flip-flop "IN" output controls a zero detector which (a) enables the clock, allowing clock pulses to pass to the first decade of the counting unit and (b) opens solid-state switch A6Q12, removing ground from the integrating capacitor and clock pulses feed into the counter. The counter can hold 100,000 counts before overflowing to 00000. The five least significant digits are obtained from decade counters and the most significant digit from a binary counter that indicates 0 and 1 only. When overflow occurs (t_3), a full scale pulse is generated that resets the input flip-flop.

The second portion of the measurement cycle now begins. The input flip-flop (a) disconnects the integrating capacitor from the output of the current rectifier and connects it instead via solid-state switch A6Q10 to a precision 1 mA constant current source having a positive output, and (b) removes its control from the zero detector and continues to allow clock pulses to reach the counter. The

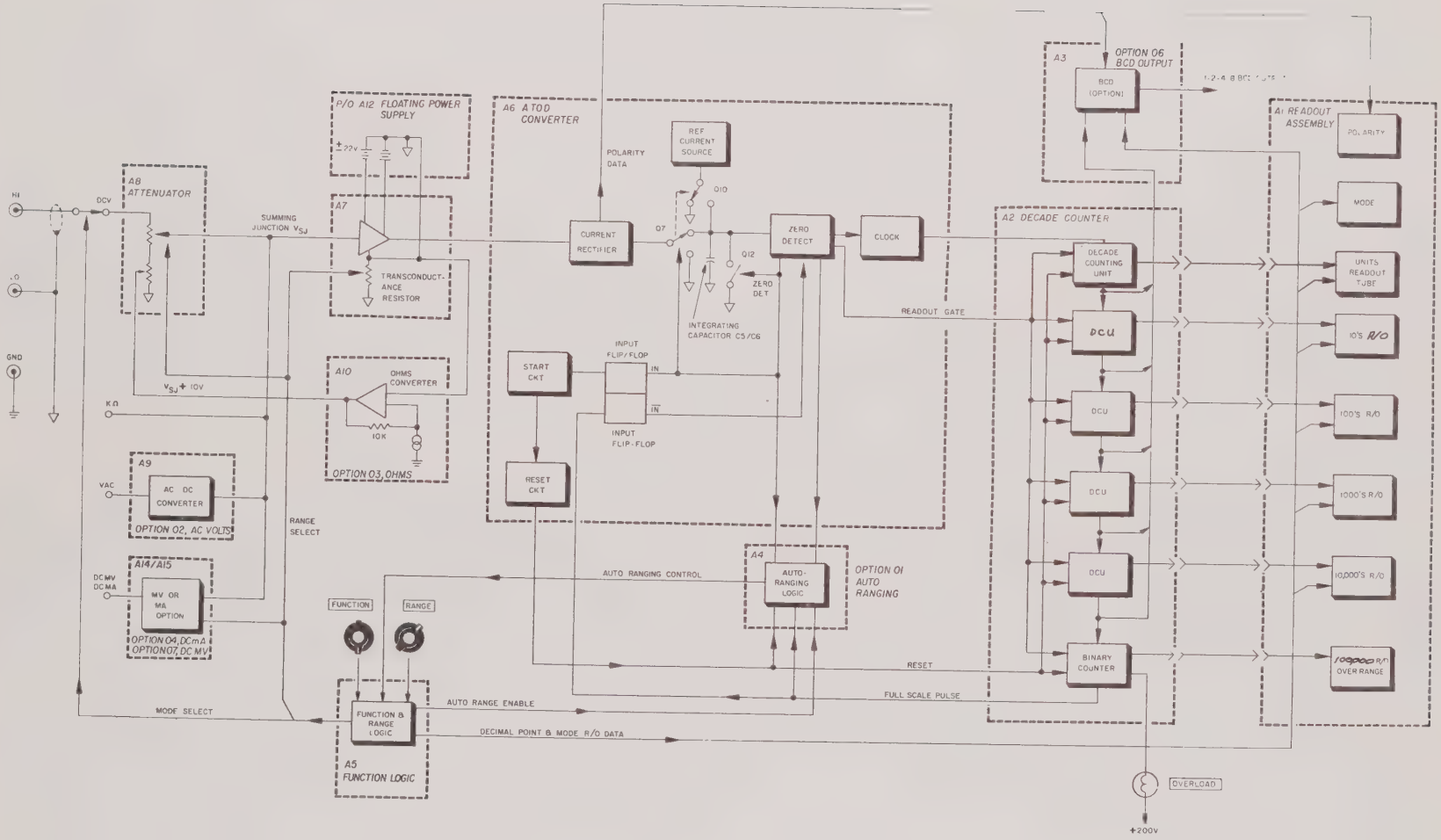


FIGURE 5-1. 7005 MULTIMETER BLOCK DIAGRAM

charge on the integrating capacitor returns to zero at a constant rate because the reference current is derived from a reference source that is stabilized and temperature compensated to a high degree. The time required for the charge to reach zero is proportional to the integrated unknown input current. Pulses counted during this period (t_3 to t_4) accumulate in the decade counter. The zero detector senses when the charge on the integrating capacitor reaches zero; and when this occurs, the clock is inhibited. The instrument now holds the measured value and the decimal readout values are gated to show the counter setting. Counter capacity,

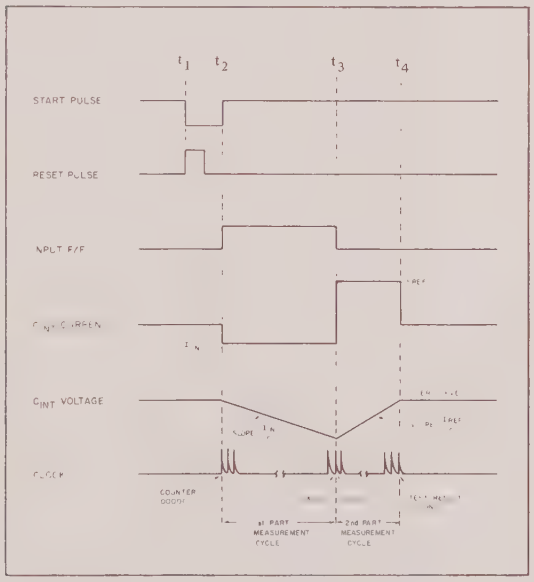


FIGURE 5-2. TEST SEQUENCE TIMING

clock frequency, and ranging are designed to give a readout in volts. When the input signal exceeds the range setting, an overload indicator (a flashing red light) is activated. Input to the overload indicator is taken from the readout so that if a 120,000 count is reached, the overload indicator is activated.

5.3 OPTION OPERATIONAL THEORY

When V AC is selected, the AC signal is converted to an equivalent DC voltage which then is measured by the DC volts circuitry previously described. The output of optional V AC assembly A9 produces a DC level proportional to the average value of the applied AC voltage. The instrument, however is calibrated in such a manner that the rms value of a pure sine wave is indicated.

DC current is measured by monitoring the voltage drop across a number of precision instrument shunts mounted on optional assembly A14. For all DC current ranges the full scale voltage drop developed across the shunt resistors is 1.0V.

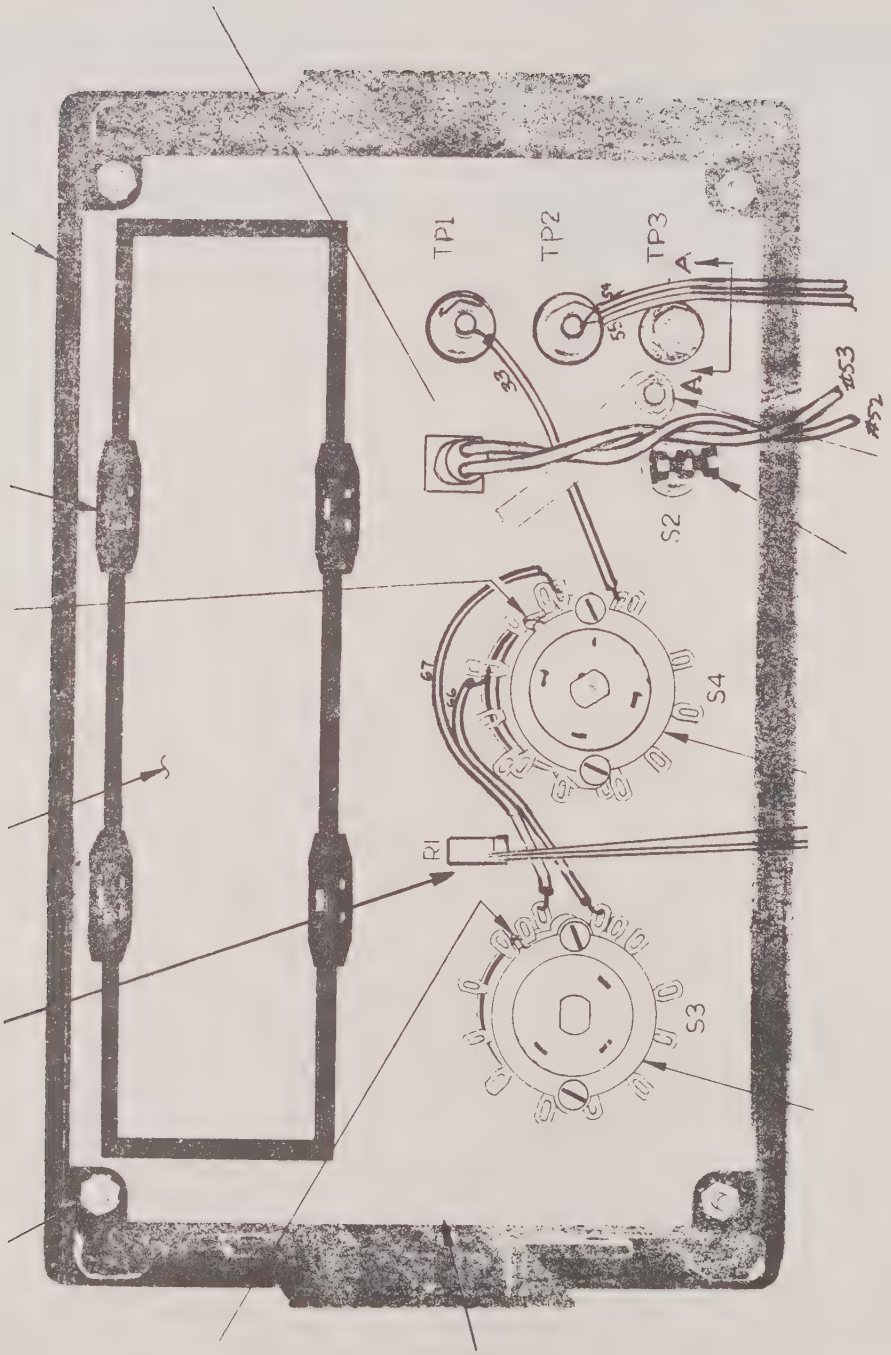
Resistance is measured by programing a constant current through the unknown resistance and measuring the resulting voltage drop with the basic DC measurement system. The optional ohms converted circuitry is mounted on assembly A10.

CHAPTER 6
CIRCUIT DESCRIPTIONS, DRAWINGS, AND PARTS LISTS

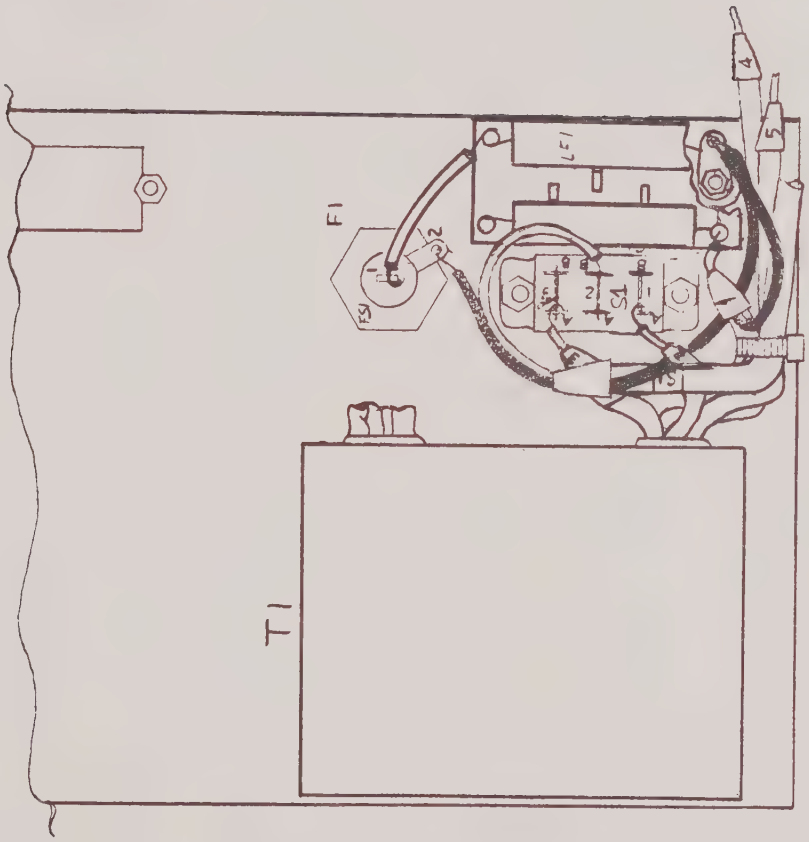
6.1 INTRODUCTION

This chapter contains circuit descriptions, drawings, and parts lists for the SD Model 7005 Multimeter. Assembly A13 Mother Board Schematic, serving as a block diagram, is shown first along with its assembly and parts list.

Immediately following the Mother Board are the standard assemblies listed in numerical order. The optional assemblies, with the assembly number in parenthesis, are next followed by the Final Assembly drawings and parts lists.



FRONT PANEL 7005 D37010D



REAR PANEL ASSEMBLY D37030B

Ref.	Description	SD Part No.	Manufacturer Part No.
	Main Assembly - Electrical		
A1	Assembly, Readout	37016	SD
A2	Assembly, Counter	37020	SD
A3	Assembly, BCD (Option 05)	39274	SD
A4	Assembly, Autorange (Option 01)	93000184	SD
A5	Assembly, Function Logic	33976	SD
A6	Assembly, A-D Converter	33857	SD
A7	Assembly, Input Amplifier	33861	SD
A8	Assembly, DC Attenuator	37045	SD
A9	Assembly, AC Converter (Options 02/06)	39235	SD
A10	Assembly, Ohms Converter (Option 03)	39230	SD
A11	Assembly, Jumper Board (See Note 1)	40036741	SD
A12	Assembly, Power Supply Regulator	93000112	SD
A13	Assembly, Mother Board	37036	SD
A14	Assembly, Current Shunts (Option 04)	93000194	SD
A15	Assembly, Preamplifier (Option 07)	39231	SD
A16	Assembly Guard/Calibration	39298	SD
	Main Assembly - Miscellaneous		
	Cord, Power	50303270	Beldon 17258
	Cover, Top	33042461	SD
	Cover, Bottom	33042501	SD
	Foot, Rubber (4 ea.)	38023910	SD
	Foot, Instrument (4 ea.)	38020031	SD
	Tilt Support	35071973	SD
	Speed Nut, T-Type (4 ea.)	36011680	SD
	Screw, Flathead 6-32 x 3/8 (4 ea.)	60112650	SD
	Handle Strap (2 ea.)	64018611	SD
	Main Assembly - Front Panel		
DS1	Lamp Cartridge, red (w/lamp)	I0075	Ind. Devices 2150443
R1	Resistor, variable, 100 kΩ	R2610	IRC 255-60
S2	Switch, Toggle (Power)	05032490	Alco MST 105D
S3	Switch, Rotary (Range)	05029741	SD
S4	Switch, Rotary (Function)	05029751	SD
TP1	Binding Post, red	51017810	Grayhill 29-1R
TP2	Binding Post, black	51017800	Grayhill 29-1B
TP3	Binding Pot, white	51023860	Grayhill 29-1W

Ref.	Description	SD Part No.	Manufacturers Part No.
	Shorting Bar	E0317	H. H. Smith
	Knob, black w/skirt (2 ea.)	45011420	Raytheon 70B-3-2G
	Bezel, readout	64018561	SD
	Retaining Clip, Bezel	36011690	SD
	Readout Filter, Polaroid	48006661	SD
	Main Assembly - Rear Panel		
LF1	Line Filter, Assembly (Prewired)	31331-4-1	SD
F1	Fuse, 1/2A Slo-Blo, 125V	11009140	Littlefuse 3AG 313.500
FS1	Fuseholder	11009210	Buss HKP
S1	Switch, Slide, DPDT	05033390	Microswitch BZ 2RW80
T1	Transformer Assembly (Prewired)	9300142	SD
	Cover, Connector (See Note 2)	35077811	SD
	Binding Post, red (See Note 3)	51017810	Grayhill 29-1R
	Binding Post, black (See Note 3)	51017800	Grayhill 29-1B
	Binding Post, white (See Note 3)	51023860	Grayhill 29-1W
	Accessories (Optional)		
	Rack Mount Kit, Single Unit w/o Slides	95000300	SD
	Rack Mount Kit, Single Unit with Slides	95001400	SD
	Rack Mount Kit, Dual Units w/o Slides	95000400	SD
	Rack Mount Kit, Dual Units with Slides	95000500	SD
	Bench Handles, pr.	95000600	SD
	Heavy Duty Carrying Case	68033301	SD

Note 1: Not included when Opt. 04 or 07 installed
Note 2: Not included when Opt. 05 installed
Note 3: Included only when Opt. 08 installed

CIRCUIT DESCRIPTION
A1,A2 COUNT READOUT AND DECADE COUNTER ASSEMBLIES
SCHEMATIC D37017E

The decade counter consists of five identical CμL958 integrated circuit elements. Each element consists of four cascaded binary flip-flops modified by a feedback loop to count in 1-2-4-8 binary-coded-decimal. The output pulses from the clock oscillator are fed to the first of the four cascaded counting elements and the counter accumulates the number of pulses received. Outputs (in the form of negative voltage steps) from each of the counting elements are coupled to the inputs of a μL959 Buffer/Storage unit. This allows the state of the counter output stage to be sampled and held for a controlled amount of time. In addition, it provides both true and complement signals; the true signal being presented to a CμL960 decimal Decoder/Driver, while its complementary signal is utilized as an output to the BCD circuitry.

The CμL960 Decoder/Driver accepts 1-2-4-8 BCD inputs at integrated circuit levels and produces 10 mutually exclusive outputs that directly control the ionizing potentials of a gas-filled, cold cathode indicator tube. A number, 0 through 9, is presented at each readout tube in accordance with the count recorded in that particular stage.

Besides clock pulses, other circuit inputs to the counter are: A reset pulse from the measurement start circuitry on board A6, and a gate pulse generated in the zero detector on board A6. At the start of a measurement sequence, the reset pulse sets the counter to 000000. During the first half of the conversion cycle clock pulses drive the counter to 100000 and the reset pulse generated in A6Q24 resets the count chain to zero.

During the second half of the measurement cycle, the counter advances from 000000 until the zero detector inhibits the clock, stopping the count. The signal occuring at overspill, called the FULL SCALE pulse, is fed back to the analog-to-digital circuitry and causes the change over from one-half of the measurement cycle to the other. The number stored in the counter when the clock pulses stop is the test result. The gate pulse generated at this time changes the readout to the new count information stored in the buffer/storage elements.

Overrange Digit

The most signigicant digit counter differs from the decade counters in that it can have only one of two states, either a "1" or a "0" (binary counter). When the measurement cycle begins, the counter is reset to 000000, and is again reset to zero during the time that the clock oscillator is shut down at the beginning of the second half of the measurement cycle.

Decimal Readout

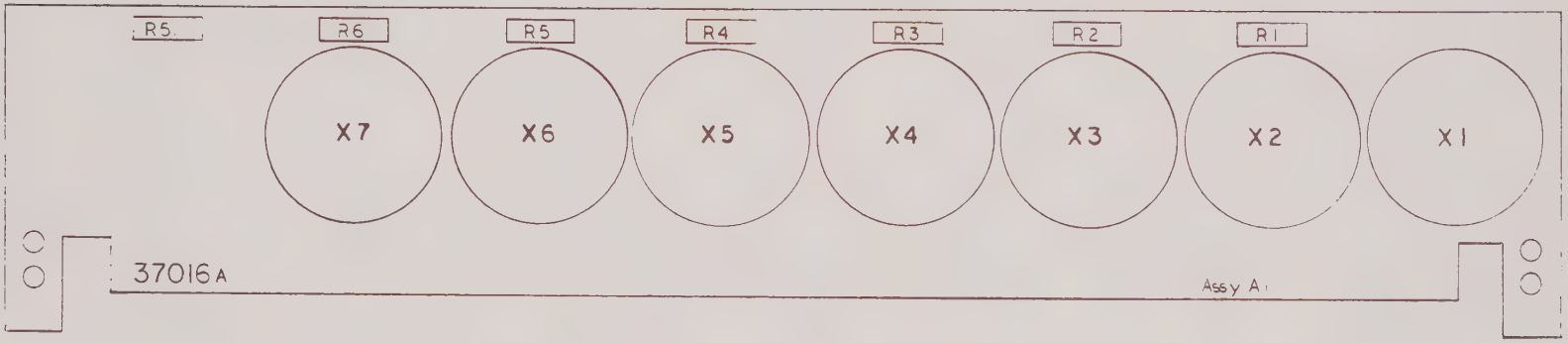
Included in the counter circuitry on board A2 are four transistors that are used as decimal point drivers. When a range is selected, the decimal point driver for that range is turned on and its low going collector voltage causes the corresponding decimal point indicator to light. Four such drivers indicate all possible readout ranges of the instrument.

Polarity Indication

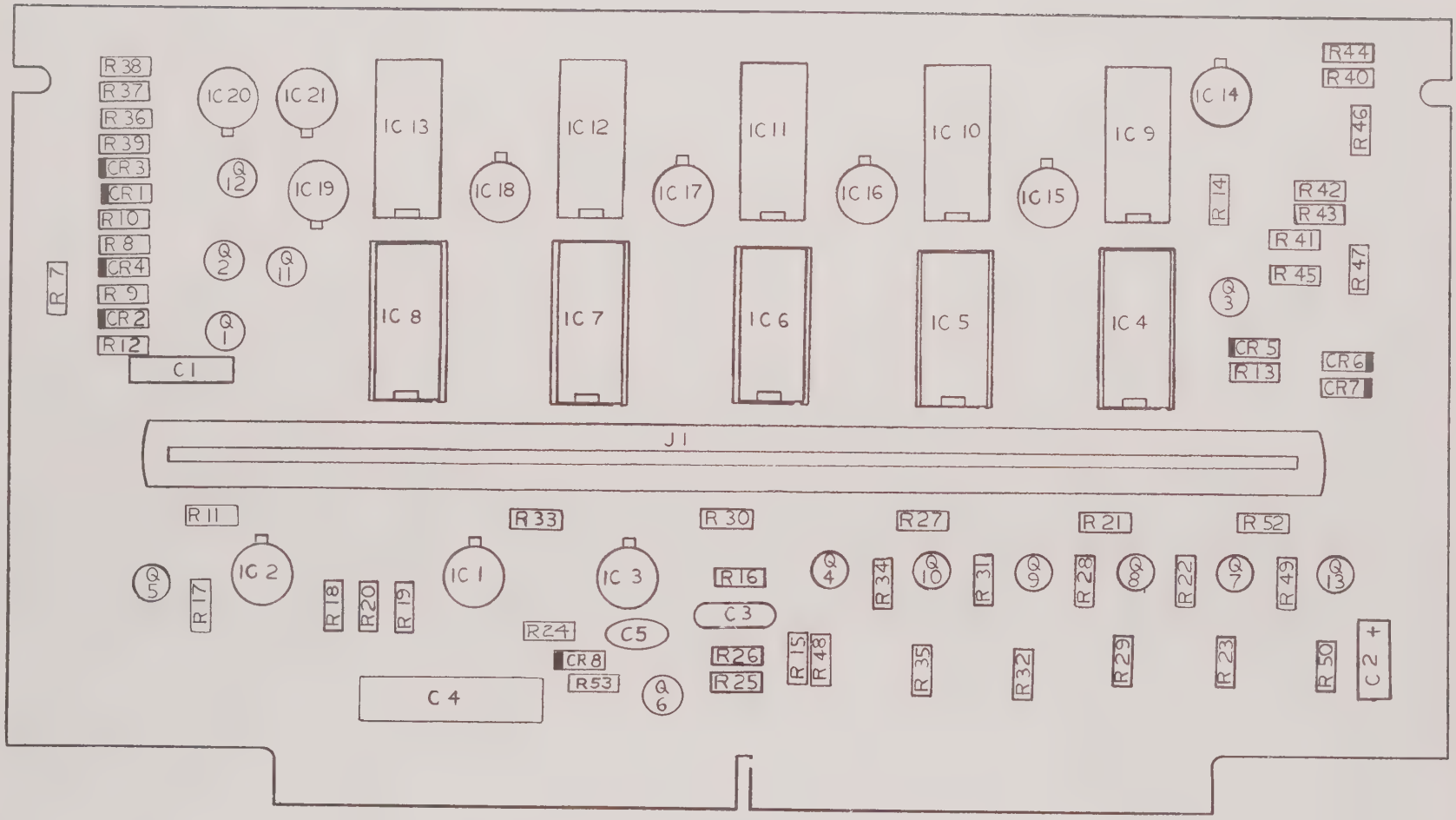
The polarity indicating circuit is operational during DC voltage and current measurements only. (For the other three

modes no polarity indication is necessary.) When either DC V or DC MA is selected, diode A2CR6 or A2CR7 conducts, shunting current away from the base of A2Q3, turning this transistor off. With A2Q3 turned off, diodes A2CR1 and A2CR3 are reverse biased, and polarity transistors A2Q1 and A2Q2 are enabled. When functions other than DC V or DC MA are selected, A2Q3 conducts and forces A2Q1 and A2Q2 to remain off, inhibiting the polarity indicator. With negative input voltages the base of A2Q1 is clamped to near ground and is turned off; additionally A2Q3 is held on by the positive current on its base delivered from the +200 V source through A2R8 and A2R10. When A2Q2 is turned on, its collector voltage causes the (-) cathode of POLARITY indicator A1V1 to go low. A potential difference of approximately 200 V then exists between the lamp's cathode and anode so that when the lamp conducts, a negative polarity indication is given.

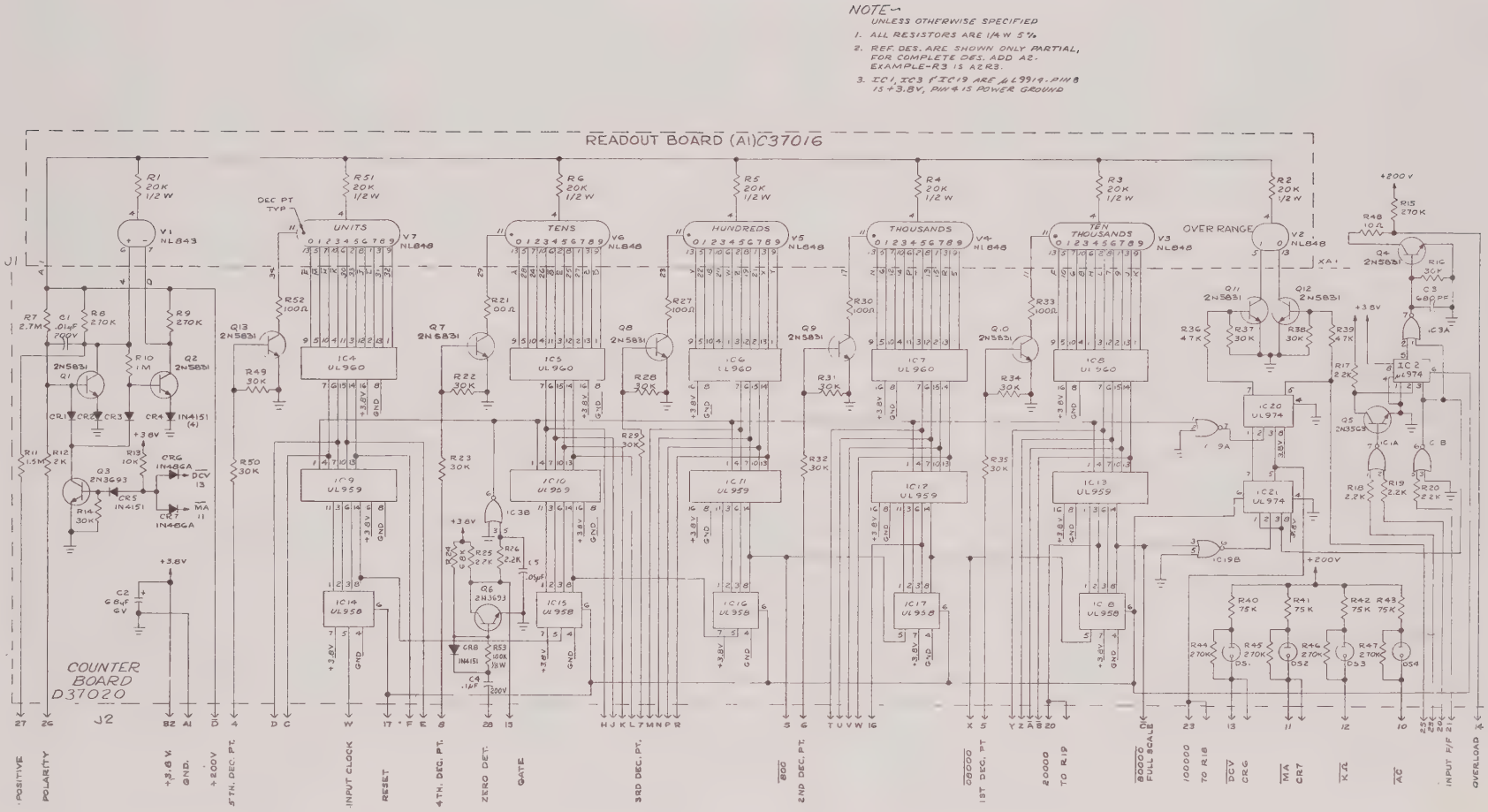
When input signals of positive polarity are measured with the Model 7005, A6Q5 is off and A2Q1 is turned on. The collector of A2Q1 then goes low, pulling the (+) cathode of POLARITY indicator A1V1 low. A 200 V potential now exists between the (+) cathode and the anode of A1V1 and the (+) sign is lit. Simultaneously, a negative voltage step is applied to the BCD circuit for external data logging.



A1 READOUT P.C. ASSEMBLY C37016A



A2 COUNTER P.C. ASSEMBLY D37020E



A1,A2 READOUT & COUNTER SCHEMATIC D37017E

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, .01µF, 200V	03278670	Sprague 192P10392
C2	Capacitor, fixed, 6.8µF, 6V	03280370	Sprague 150D685X9006A2
C3	Capacitor, fixed, 680pF, 300V	03281540	Elmenco DM15-681J
C4	Capacitor, fixed, .1µF, 500V	03278960	TRW 663F10492W2
C5	Capacitor, fixed, .05µF, 12V	C0672	RMC Type M-12
CR1	Diode, IN4151	CR0150	FSC
CR2	Diode, IN4151	CR0150	FSC
CR3	Diode, IN4151	CR0150	FSC
CR4	Diode, IN4151	CR0150	FSC
CR5	Diode, IN4151	CR0150	FSC
CR6	Diode, IN486A	26014570	FSC
CR7	Diode, IN486A	26014570	FSC
CR8	Diode, IN4151	CR0150	FSC
IC1	Integrated Circuit, L914	26010980	
IC2	Integrated Circuit, L974	26012480	FSC
IC3	Integrated Circuit, L914	26010980	
IC4	Integrated Circuit, L960	26012430	FSC U6B996079X
IC5	Integrated Circuit, L960	26012430	FSC U6B996079X
IC6	Integrated Circuit, L960	26012430	FSC U6B996079X
IC7	Integrated Circuit, L960	26012430	FSC U6B996079X
IC8	Integrated Circuit, L960	26012430	FSC U6B996079X
IC9	Integrated Circuit, L959	26012420	FSC U6B995979X
IC10	Integrated Circuit, L959	26012420	FSC U6B995979X
IC11	Integrated Circuit, L959	26012420	FSC U6B995979X
IC12	Integrated Circuit, L959	26012420	FSC U6B995979X
IC13	Integrated Circuit, L959	26012420	FSC U6B995979X
IC14	Integrated Circuit, L958	26012410	FSC U6B995979X
IC15	Integrated Circuit, L958	26012410	FSC U6B995979X
IC16	Integrated Circuit, L958	26012410	FSC U6B995979X
IC17	Integrated Circuit, L958	26012410	FSC U6B995979X
IC18	Integrated Circuit, L958	26012410	FSC U6B995979X
IC19	Integrated Circuit, L914	26010980	FSC U5B991429X
IC20	Integrated Circuit, L974	26012480	FSC
IC21	Integrated Circuit, L974	26012480	FSC
Q1	Transistor, S20364	26004021	FSC TXB4207MXX
Q2	Transistor, S20364	26004021	FSC TXB4207MXX
Q3	Transistor, 2N3693	26012020	FSC TXY1243ECX
Q4	Transistor, 2N720A	26010850	FSC TCB4205MBX
Q5	Transistor, 2N3563	26012050	FSC TXY1211EXX

Ref.	Description	SD Part No.	Manufacturers Part No.
Q6	Transistor, 2N3693	26012020	FSC TXY1243ECX
Q7	Transistor, 2N5831	26004021	
Q8	Transistor, 2N5831	26004021	
Q9	Transistor, 2N5831	26004021	
Q10	Transistor, 2N5831	26004021	
Q11	Transistor, 2N5831	26004021	
Q12	Transistor, 2N5831	26004021	
Q13	Transistor, 2N5831	26004021	
R1	Not Used		
R2	Not Used		
R3	Not Used		
R4	Not Used		
R5	Not Used		
R6	Not Used		
R7	Resistor, fixed, 2.7 MΩ, 5%, 1/4W	R1020	AB
R8	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R9	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R10	Resistor, fixed, 1 MΩ, 5%, 1/4W	R0962	AB
R11	Resistor, fixed, 1.5 MΩ, 5%, 1/4W	R1204	AB
R12	Resistor, fixed, 2 kΩ, 5%, 1/4W	R0734	AB
R13	Resistor, fixed, 10 kΩ, 5%, 1/4W	R0766	AB
R14	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R15	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R16	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R17	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R18	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R19	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R20	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R21	Resistor, fixed, 100Ω, 5%, 1/4W	R0966	AB
R22	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R23	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R24	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	R0696	AB
R25	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R26	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	R0749	AB
R27	Resistor, fixed, 100Ω, 5%, 1/4W	R0966	AB
R28	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R29	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R30	Resistor, fixed, 100Ω, 5%, 1/4W	R0966	AB

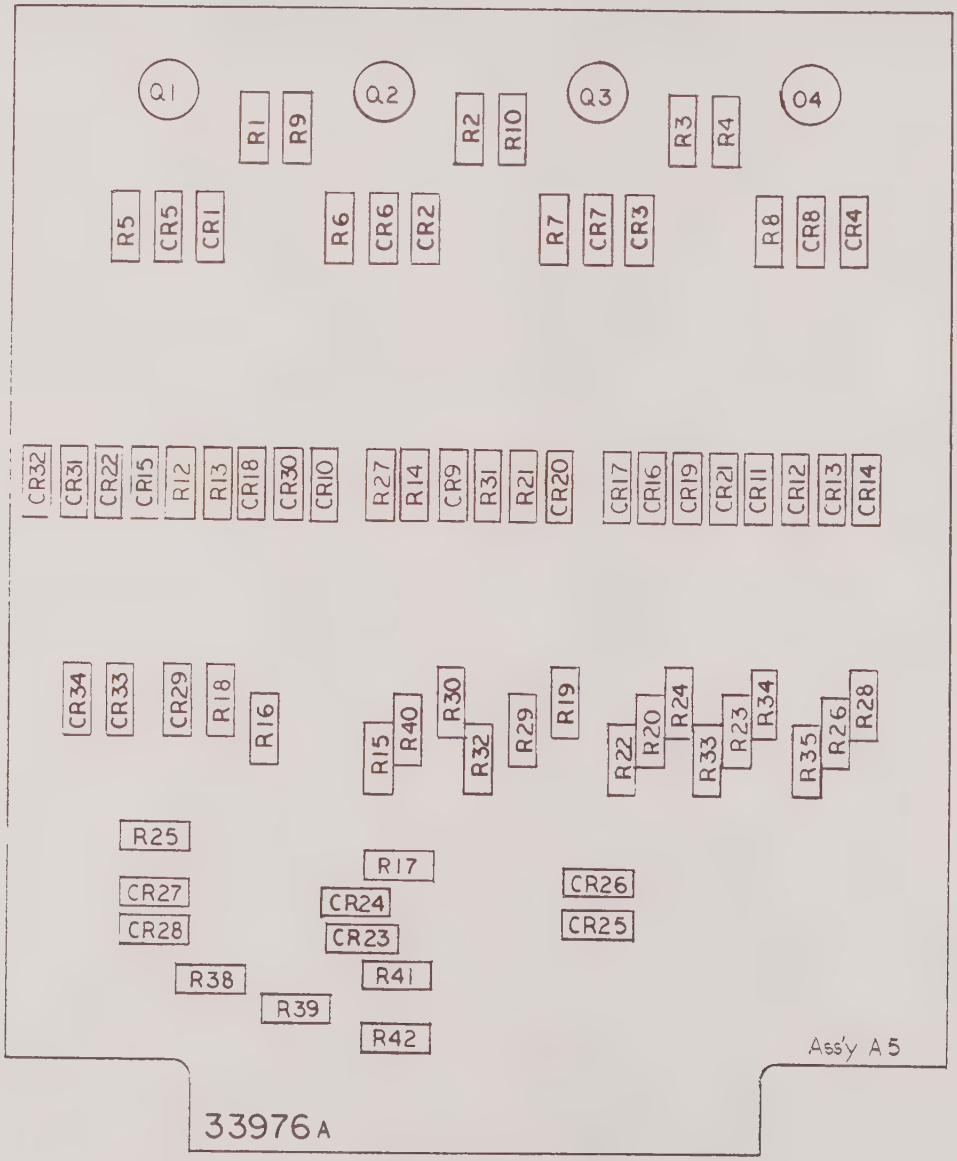
Ref.	Description	SD Part No.	Manufacturers Part No.
R31	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R32	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R33	Resistor, fixed, 100Ω, 5%, 1/4W	R0966	AB
R34	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R35	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R36	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	R0892	AB
R37	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R38	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R39	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	R0892	AB
R40	Resistor, fixed, 75 kΩ, 5%, 1/4W	R0976	AB
R41	Resistor, fixed, 75 kΩ, 5%, 1/4W	R0967	AB
R42	Resistor, fixed, 75 kΩ, 5%, 1/4W	R0967	AB
R43	Resistor, fixed, 75 kΩ, 5%, 1/4W	R0967	AB
R44	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R45	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R46	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R47	Resistor, fixed, 270Ω, 5%, 1/4W	R1622	AB
R48	Resistor, fixed, 10Ω, 5%, 1/4W	R0739	AB
R49	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R50	Resistor, fixed, 30 kΩ, 5%, 1/4W	R0715	AB
R51	Not Used		
R52	Resistor, fixed, 100Ω, 5%, 1/4W	R0966	AB
R53	Resistor, fixed, 100k, 1/8W	R2465	AB
XIC4	Socket, Integrated Circuit	X0174	Augat 316-AG-5D-2R
XIC5	Socket, Integrated Circuit	X0174	Augat 316-AG-5D-2R
XIC6	Socket, Integrated Circuit	X0174	Augat 316-AG-5D-2R
	Socket, Integrated Circuit	X0174	Augat 316-AG-5D-2R
XIC8	Socket, Integrated Circuit	X0174	Augat 316-AG-5D-2R
DS1	Annunciator Assembly (complete)	37032	SD
	Including:		
	1 Housing (1 ea.)	33041701	SD
	2 Lamp, neon (4 ea.) NE-2U	12013110	
	3 Reflector (4 ea.)	48006741	SD
	4 Rod, readout light (4 ea.)	74036021	SD
	5 Cover, readout block (1 ea.)	33041711	SD
	6 Lens, readout (1 ea.)	45013221	SD
	7 Film, MADC	33994	SD
	or Film, MVDC	33993	SD

A1 READOUT ASSEMBLY

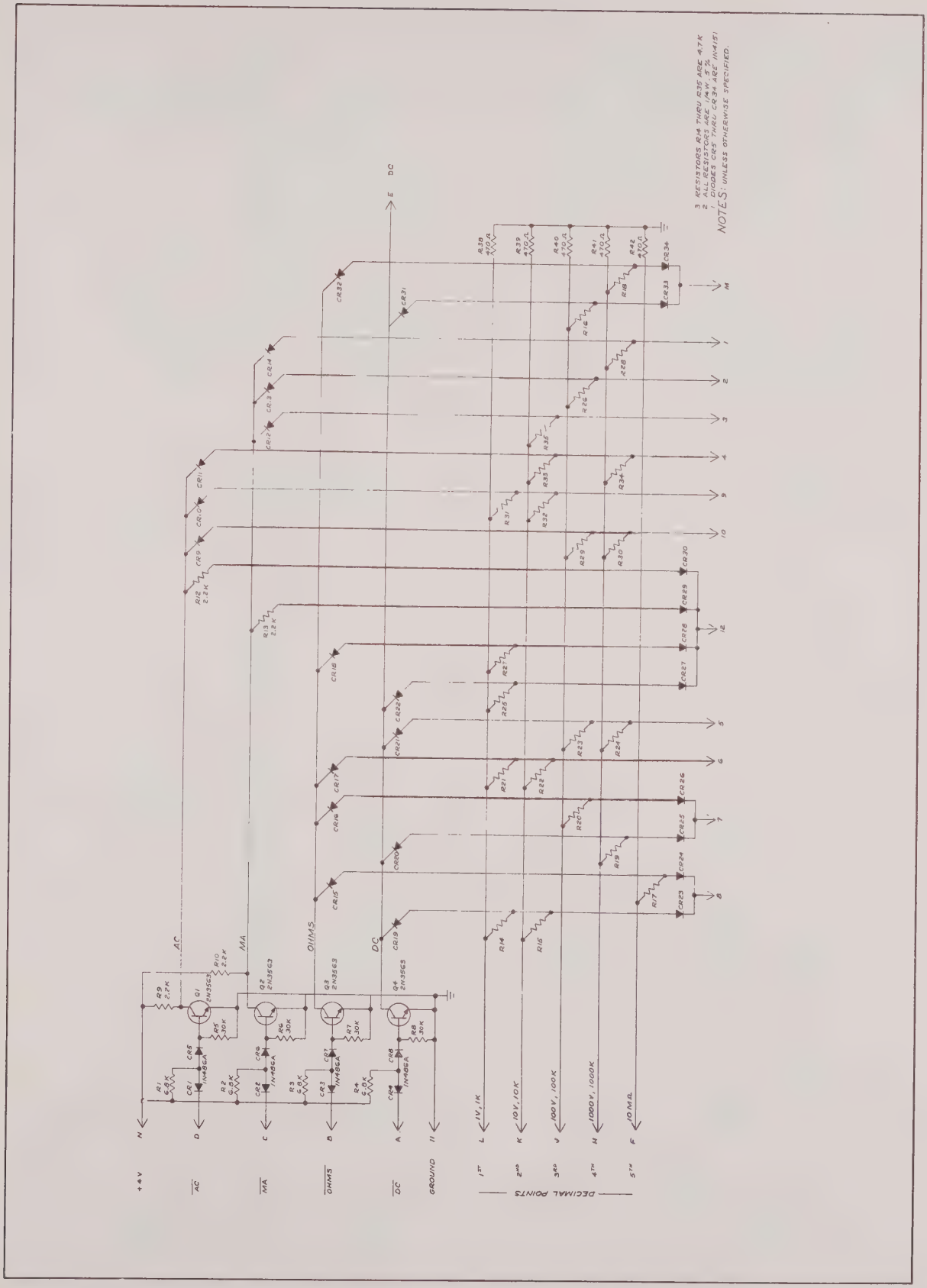
Ref.	Description	SD Part No.	Manufacturers Part No.
R1	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R2	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R3	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R4	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R5	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R6	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
R51	Resistor, fixed, 20 kΩ, 5%, 1/2W	02030790	AB
V1	Tube, readout (polarity)	25015520	National Electronics NL848
V2	Tube, readout (numerals)	25015510	National Electronics NL848
V3	Tube, readout (numerals)	25015510	National Electronics NL848
V4	Tube, readout (numerals)	25015510	National Electronics NL848
V5	Tube, readout (numerals)	25015510	National Electronics NL848
V6	Tube, readout (numerals)	25015510	National Electronics NL848
V7	Tube, readout (numerals)	25015510	National Electronics NL848
XV1	Socket, Tube	34011530	National Electronics RTS-18
XV2	Socket, Tube	34011530	National Electronics RTS-18
XV3	Socket, Tube	34011530	National Electronics RTS-18
XV4	Socket, Tube	34011530	National Electronics RTS-18
XV5	Socket, Tube	34011530	National Electronics RTS-18
XV6	Socket, Tube	34011530	National Electronics RTS-18
XV7	Socket, Tube	34011530	National Electronics RTS-18

CIRCUIT DESCRIPTION
A5 FUNCTION LOGIC P.C. ASSEMBLY
SCHEMATIC #D33979A

The Function Logic is a mode matrix with inputs from the function and range switches. Function inputs are ground for the selected function, range inputs and decimal points are +12V for the selected range. Outputs drive the reed coils.



A5 FUNCTION LOGIC P.C. BOARD C33976A



A5 FUNCTION LOGIC SCHEMATIC D33979A

Ref.	Description	SD Part No.	Manufacturers Part No.
CR1	Diode, IN486A	26014570	FSC
CR2	Diode, IN486A	26014570	FSC
CR3	Diode, IN486A	26014570	FSC
CR4	Diode, IN486A	26014570	FSC
CR5	Diode, IN4151	CR0150	FSC
CR6	Diode, IN4151	CR0150	FSC
CR7	Diode, IN4151	CR0150	FSC
CR8	Diode, IN4151	CR0150	FSC
CR9	Diode, IN4151	CR0150	FSC
CR10	Diode, IN4151	CR0150	FSC
CR11	Diode, IN4151	CR0150	FSC
CR12	Diode, IN4151	CR0150	FSC
CR13	Diode, IN4151	CR0150	FSC
CR14	Diode, IN4151	CR0150	FSC
CR15	Diode, IN4151	CR0150	FSC
CR16	Diode, IN4151	CR0150	FSC
CR17	Diode, IN4151	CR0150	FSC
CR18	Diode, IN4151	CR0150	FSC
CR19	Diode, IN4151	CR0150	FSC
CR20	Diode, IN4151	CR0150	FSC
CR21	Diode, IN4151	CR0150	FSC
CR22	Diode, IN4151	CR0150	FSC
CR23	Diode, IN4151	CR0150	FSC
CR24	Diode, IN4151	CR0150	FSC
CR25	Diode, IN4151	CR0150	FSC
CR26	Diode, IN4151	CR0150	FSC
CR27	Diode, IN4151	CR0150	FSC
CR28	Diode, IN4151	CR0150	FSC
CR29	Diode, IN4151	CR0150	FSC
CR30	Diode, IN4151	CR0150	FSC
CR31	Diode, IN4151	CR0150	FSC
CR32	Diode, IN4151	CR0150	FSC
CR33	Diode, IN4151	CR0150	FSC
CR34	Diode, IN4151	CR0150	FSC
Q1	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q2	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q3	Transistor, 2N3563	26012050	FSC TXY1211EXX

Ref.	Description	SD Part No.	Manufacturers Part No.
Q4	Transistor, 2N3563	26012050	FSC TXY1211EXX
R1	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R2	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R3	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R4	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R5	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R6	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R7	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R8	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R9	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354990	AB
R10	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354990	AB
R11	Not Used		
R12	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354990	AB
R13	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354990	AB
R14	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R15	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R16	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R18	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R19	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R20	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R21	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R22	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R23	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R24	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R25	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R26	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R27	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R28	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R29	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R30	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R31	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R32	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R33	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R34	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R35	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R36	Not Used		
R37	Not Used		

Ref.	Description	SD Part No.	Manufacturers Part No.
R38	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB
R39	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB
R40	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB
R41	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB
R42	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB

CIRCUIT DESCRIPTION
ANALOG-TO-DIGITAL CONVERTER A6
SCHEMATIC #D33860A

After the unknown signal has been converted to a DC current proportional to the magnitude of the unknown input voltage, it is fed to analog-to-digital converter A6. This board contains (a) sequence control logic including the start and reset circuits and (b) dual slope integrating circuitry including the current rectifier, reference current generator, zero detector, and clock.

Start and Reset

The start circuit is a free-running multivibrator that produces pulses at a rate of 5 pulses per second for all modes of operation except V AC; for V AC the rate is 1 pulse per second. The leading edge of the start pulse (negative going) triggers the reset generator which in turn resets the counter to 00000. The trailing edge of the pulse (positive going) sets the input flip-flop.

In operation, the pulse rate of the start circuit depends jointly on the RC time constant of A6C12 and A6R57/A6R72; and the reference voltage set by A6R70 and A6R71. For all test modes except V AC, A6R57 and A6R72 are in parallel and give a sampling rate of approximatley 5 pulses per second; for the V AC test, the V AC input from the mode logic goes to ground and only A6R57 is in circuit. This changes the sampling rate to 1 pulse per second. The output waveform is created as follows: Through regenerative coupling, A6Q19 is turned on and off alternately with A6 Q20. When A6Q20 is on, the voltage at its emitter rises to +4V and voltage divider A6R70, A6R71 puts 2 V on the emitter of A6Q19, holding it off. Capacitor A6C12 now starts charging to +4V through A6R57. As the voltage across A6C12 becomes larger (approximately 2.5 V), A6Q19 is turned on, turning A6Q20 off. The emitter of A6Q20 goes low causing A6C12 to discharge through A6R57. The charge on A6C13 eventually falls too low to keep A6Q29 turned on; so A6Q19 is turned off and the cycle is repeated at a rate of 5 pulses per second. The clamp input to the base of A6Q19 from the zero detector prevents A6C12 from charging during the time that the measurement cycle is taking place. The sample rate is thus timed from the moment that the zero detector reaches null and a readout is presented.

The reset pulse is generated by A6Q21. This transistor is normally off until triggered by the leading edge of the start pulse. At this time it generates a short positive pulse which resets the instrument circuits prior to the start of the measurement cycle (and of start pulse).

The "PRINT HOLD" circuit is provided for use with external equipment. Solid-state switch A6Q18 can be turned on by an external source. When this occurs, the voltage across A6C12 is clamped to ground and the start circuit is inhibited.

Current Rectifier

The output signal from the input amplifier is applied to a current rectifying circuit located on assembly A6. The purpose of the rectifier is to maintain the linear relationship of the input current generated by the amplifier (full scale = 1 mA), but with a constant negative polarity regardless of the polarity of the signal being measured.

For negative currents, $I_{in} = I_{out}$ through CR2. For positive currents, the signal is routed through CR1 into A6R33. This creates a voltage drop of $V_{R33} = I_{in}$ R33. Negative feedback makes the voltage across A6R34: $V_{R34} = -V_{R33} = -I_{in}$ R33. The current in A6R34 is the current drained from the integrating capacitor. Therefore:

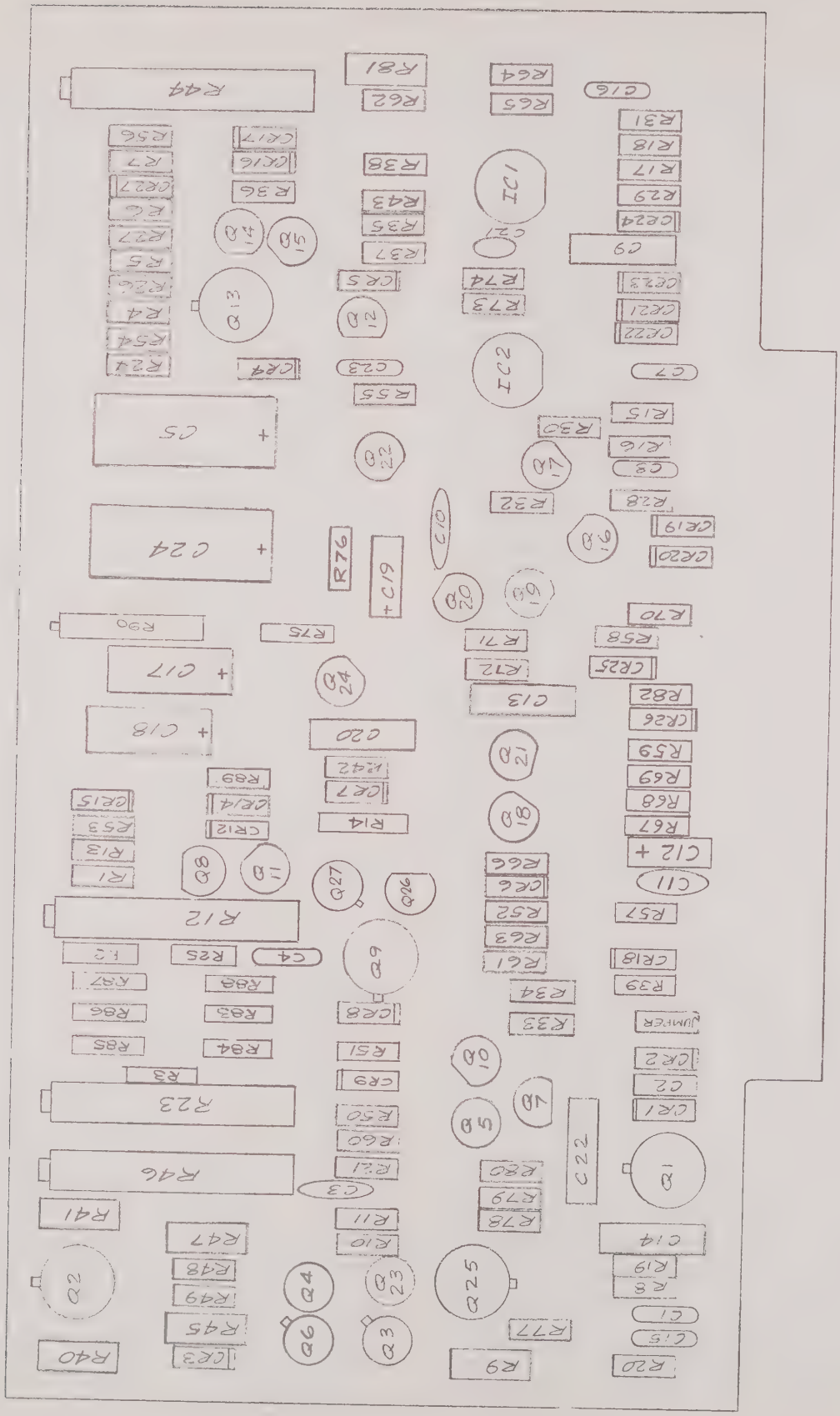
$$I_{out} = -\frac{V_{R34}}{R_{34}}$$

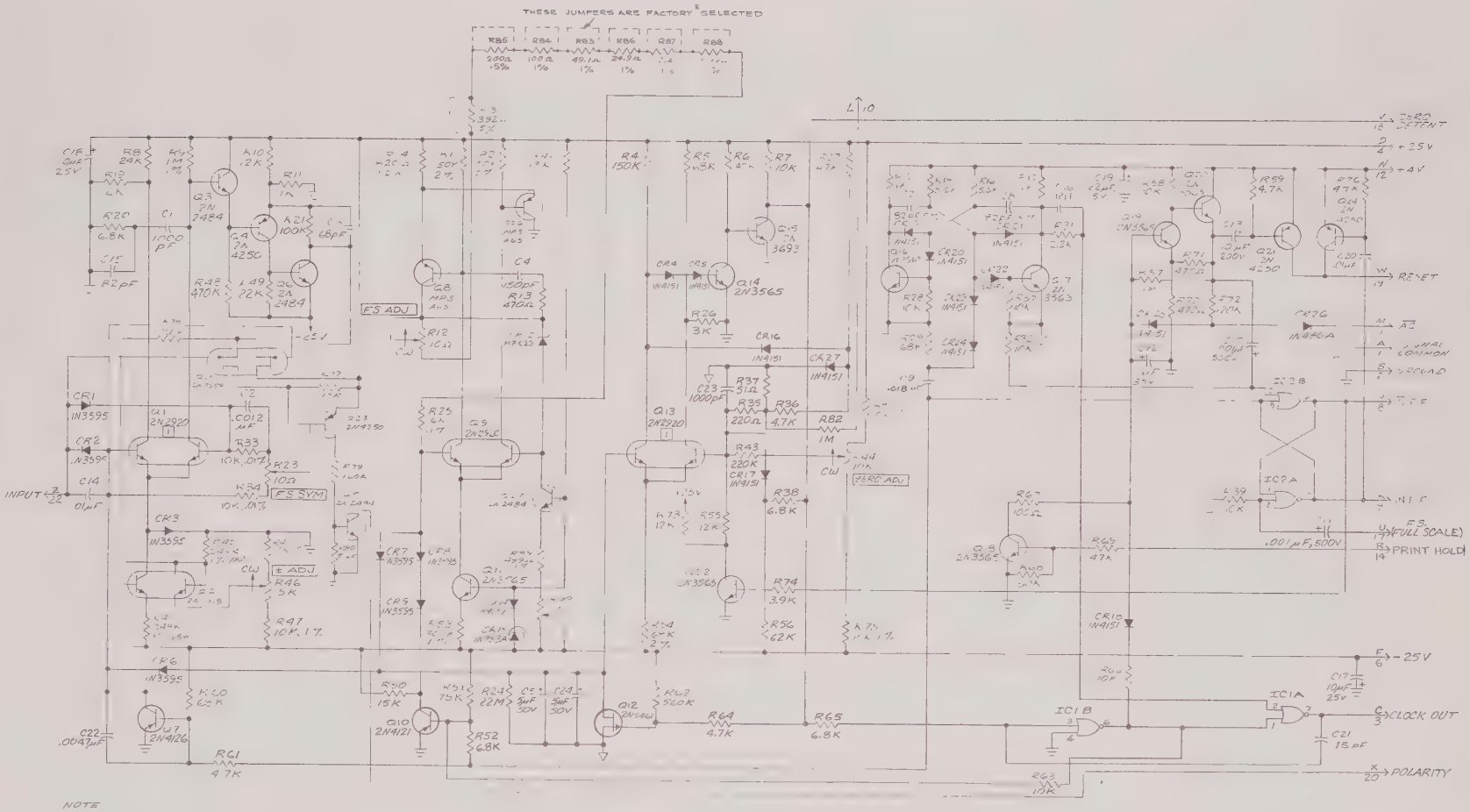
Transistor A6Q1 is a differential stage with A6Q2 connected as a constant current source. The output signal at the collector A6Q1B is coupled to the base of emitter follower A6Q3. The output from A6Q3 is coupled to A6Q4, output of A6Q4 to A6Q6 which drives the two feedback resistors A6R33 and A6R34.

Polarity is sensed by determining the polarity of the voltage drop across the diode A6CR2. If the input current to this assembly is negative, then this diode is conducting. If the input current is positive, then A6CR1 is forward biased and A6CR2 is backbiased by an amount nearly equal to the forward bias on A6CR1. A voltage change greater than 1 volt is thus available to use in determining the polarity of the input current. This voltage is amplified by the balanced FET amplifier, A6Q25 and following stages A6Q23 and A6Q5. The output of A6Q5 is the polarity signal and terminal A6(20,X) is high when the input voltage to the instrument is positive, and clamped to ground when input voltage is negative.

Reference Current Generator

The reference generator supplies a positive current of 1 mA to the integrating capacitor during the second half of the measurement cycle. Zener diode A6CR12 is the reference diode connected from the output to the negative input of a high gain direct coupled amplifier, A6(Q9,Q8,Q26,Q11) and series resistance combination of A6R(3,12,25,83,84,85,86, 87, and 88) is connected from the same output to the positive input of the same amplifier. When current is being supplied to the integrating capacitor the voltage on the base of A6Q9 connected to A6R25 is one diode drop more positive than the voltage on the integrating capacitor, A6(C5,C24), and as the capacitor charges positive, the output of the amplifier also goes positive by an equal amount and tends to keep a constant voltage across the series feedback resistor. The voltage drop across the Zener reference diode will be 6.2 ±0.3% volts and the feedback resistor is adjusted in value so that 1 mA will flow in it to establish a voltage drop essentially equal to the Zener diode voltage drop. Coarse adjustments are made by shorting the appropriate resistors in the set of seven resistors, R3,R83,R84,R86,R87, and R88, which are related to each other by factors of 2, and allow for the selection of 128 values between zero and 785 ohms in about 6.2 ohm steps. Fine adjustment is made with A6R12. A6CR15 and A6CR14 in combination with A6Q11 and A6R53 provide a constant current source for the emitters of A6Q9. A6CR15 and A6CR14 in combination with A6Q27, A6R89 and A6R90 provide the constant current source for the Zener reference diode, A6CR12. The value of this current can be changed by the adjustment of A6R90. This adjustment is made in the factory tests to select a current which will yield a nearly zero temperature coefficient of full-scale sensitivity and should not be changed unless equipment is available to make tests, at several


A6 A-D CONVERTER P.C. ASSEMBLY D37408C



NOTE

1. Q1, & 13 ARE SELECTED PER DRAWING 33830
2. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE 5%, 1/4W.
3. IC1 & IC2 ARE μL9914. PIN 8 IS +3.8V PIN 4 IS POWER GROUND.

A6 A-D CONVERTER SCHEMATIC D37411C

A6 A-D CONVERTER ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, 1000pF, 100V	C1144	Sangamo D151E102J
C2	Capacitor, fixed, .0012μF, 200V	C0967	Sprague 192P12202
C3	Capacitor, fixed, 68pF, 500V	03175240	Elmenco DM15-680J
C4	Capacitor, fixed, 150pF, 300V	03281360	Elmenco CM15-151J
C5	Capacitor, fixed, 5μF, 50V	C1221	TRW X4835059
C6	Not Used		
C7	Capacitor, fixed, 82pF, 500V	C0873	Elmenco DM15E-820J
C8	Capacitor, fixed, 82pF, 500V	C0873	Elmenco DM15E0820J
C9	Capacitor, fixed, .018μF, 200V	C0964	
C10	Capacitor, fixed, .001μF, 500V	C0611	Erie 801-000-X5F0-10
C11	Capacitor, fixed, .001μF, 500V	C0611	Erie 801-000-X5F0-10
C12	Capacitor, fixed, 1μF, 35V	C0524	Sprague 150D105X9035A2
C13	Capacitor, fixed, .01μF, 200V	03278670	Sprague 192P10392
C14	Capacitor, fixed, .01μF, 200V	03278670	Sprague 192P10392
C15	Capacitor, fixed, 82pF, 500V	C0873	Elmenco DM15E0820J
C16	Capacitor, fixed, 18pF, DM	C0697	DM10-180J500V
C17	Capacitor, fixed, 10μF, 25V	C0365	Sprague TE-1204
C18	Capacitor, fixed, 10μF, 25V	C0365	Sprague TE-1204
C19	Capacitor, fixed, 22μF, 15V	C0693	Sprague 130D226X9015C2
C20	Capacitor, fixed, .01μF, 200V	03278670	Sprague 192P10392
C21	Capacitor, fixed, 15pF, 50V	C0259	
C22	Capacitor, fixed, .0047μF, 200V	C0698	Sprague 192P47292
C23	Capacitor, fixed, 1000pF, 100V	C1144	Sangamo D15E102J
C24	Capacitor, fixed, 5μF, 50V	C1221	TRW X4835059
CR1	Diode, IN3595	26012540	FSC
CR2	Diode, IN3595	26012540	FSC
CR3	Diode, IN3595	26012540	FSC
CR4	Diode, IN4151	CR0150	FSC
CR5	Diode, IN4151	CR0150	
CR6	Diode, IN3595	26012540	FSC
CR7	Diode, IN3595	26012540	FSC
CR8	Diode, IN3595	26012540	FSC
CR9	Diode, IN3595	26012540	FSC
CR10	Not Used		
CR11	Not Used		
CR12	Diode, MZ620	CR0371	
CR13	Not Used		
CR14	Diode, IN4151	CR0150	FSC

Ref.	Description	SD Part No.	Manufacturers Part No.
CR15	Diode, IN753A	26014210	FSC
CR16	Diode, IN4151	CR0150	FSC
CR17	Diode, IN4151	CR0150	FSC
CR18	Diode, IN4151	CR0150	FSC
CR19	Diode, IN4151	CR0150	FSC
CR20	Diode, IN4151	CR0150	FSC
CR21	Diode, IN4151	CR0150	FSC
CR22	Diode, IN4151	CR0150	FSC
CR23	Diode, IN4151	CR0150	FSC
CR24	Diode, IN4151	CR0150	FSC
CR25	Diode, IN4151	CR0150	FSC
CR26	Diode, IN486A	26014570	FSC
CR27	Diode, IN4151	CR0150	FSC
IC1	Integrated Citcuit, µL914	26012450	FSC TXB1341HXX
IC2	Integrated Circuit, µL914	26012450	FSC TXY1341HXX
Q1	Transistor, (selected)	33830	SD
Q2	Transistor, 2N2918	26011110	
Q3	Transistor, 2N2484	26010670	FSC TXB1250HBX
Q4	Transistor, 2N4250	26014430	
Q5	Transistor, 2N3484	26010670	FSC TXB1250HBX
Q6	Transistor, 2N2484	26010670	FSC TXB1250HBX
Q7	Transistor, 2N4126	Q0236	Motorola
Q8	Trnasistor, MPS A65	Q0299	
Q9	Transistor, 2N2920	26011350	FSC FAA1250HA1
Q10	Transistor, 2N4121	26012650	
Q11	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q12	Transistor, 2N5461	Q0263	
Q13	Transistor, (selected)	33830	SD
Q14	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q15	Transistor, 2N3693	26012020	FSC TXY1243ECX
Q16	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q17	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q18	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q19	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q20	Transistor, 2N3565	26012000	FSC TXY1250EBX

Ref.	Description	SD Part No.	Manufacturers Part No.
Q21	Transistor, 2N4250	26014430	
Q22	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q23	Transistor, 2N4250	26014430	
Q24	Transistor, 2N4250	26014430	
Q25	Transistor, 2N3958	26015100	
Q26	Transistor, MPS A65	Q0299	
Q27	Transistor, 2N2484	26010670	
R1	Resistor, fixed, 150kΩ, 2%, 1/4W	02397900	AB
R2	Resistor, fixed, 150kΩ, 2%, 1/4W	02397900	AB
R3	Resistor, fixed, 392Ω, 5%, 1/10W	R2703	
R4	Resistor, fixed, 150kΩ, 2%, 1/4W	02397900	AB
R5	Resistor, fixed, 68kΩ, 5%, 1/4W	02355050	AB
R6	Resistor, fixed, 47kΩ, 5%, 1/4W	R0777	AB
R7	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R8	Resistor, fixed, 24kΩ, 5%, 1/4W	02354940	AB
R9	Resistor, fixed, 1MΩ, 1%, 1/8W	02394780	IRC RN60D
R10	Resistor, fixed, 12kΩ, 5%, 1/4W	02354870	AB
R11	Resistor, fixed, 1kΩ, 5%, 1/4W	02354620	AB
R12	Resistor, variable, 10Ω, 22-turn	01110200	
R13	Resistor, fixed, 470Ω, 5%, 1/4W	02354540	AB
R14	Resistor, fixed, 820kΩ, 5%, 1/2W	R1156	AB
R15	Resistor, fixed, 1kΩ, 5%, 1/4W	02354620	AB
R16	Resistor, fixed, 5.6kΩ, 5%, 1/4W	R0821	AB
R17	Resistor, fixed, 1kΩ, 5%, 1/4W	02354620	AB
R18	Resistor, fixed, 5.6kΩ, 5%, 1/4W	R0821	AB
R19	Resistor, fixed, 2kΩ, 5%, 1/4W	02354680	AB
R20	Resistor, fixed, 6.8kΩ, 5%, 1/4W	02354810	AB
R21	Resistor, fixed, 100kΩ, 5%, 1/4W	02355090	AB
R22	Not Used		
R23	Resistor, variable, 10Ω, 22-turn	01110200	
R24	Resistor, fixed, 22MΩ, 5%, 1/4W	R1058	AB
R25	Resistor, fixed, 6.0kΩ, 1%, 1/	R2692	
R26	Resistor, fixed, 3kΩ, 5%, 1/4W	02354720	AB
R27	Resistor, fixed, 47kΩ, 5%, 1/4W	R0777	AB
R28	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R29	Resistor, fixed, 68kΩ, 5%, 1/4W	02355050	AB
R30	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R31	Resistor, fixed, 2.2kΩ, 5%, 1/4W	02354690	AB
R32	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R33	Resistor, fixed, 10kΩ, .01%, .3W	02398710	Vishay S102

Ref.	Description	SD Part No.	Manufacturers Part No.
R34	Resistor, fixed, 10 kΩ, .01%, .3W	02398710	Vishay S102
R35	Resistor, fixed, 220Ω, 5%, 1/4W	02354460	AB
R36	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R37	Resistor, fixed, 51Ω, 5%, 1/4W	02354310	AB
R38	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R39	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R40	Resistor, fixed, 249kΩ, 1%, 1/8W	02394740	AB
R41	Resistor, fixed, 10 kΩ, 1%, 1/4W	R2455	Pyrofilm PME60T9
R42	Resistor, fixed, 18kΩ, 5%, 1/4W	R0785	AB
R43	Resistor, fixed, 220 kΩ, 5%, 1/4W	02355170	AB
R44	Resistor, Variable, 10 kΩ, 22-turn	R2385	Beckman 78PR10K
R45	Resistor, fixed, 249 kΩ, 1%, 1/8W	02394740	IRC
R46	Resistor, variable, 5 kΩ, 22-turn	R2415	Beckman 78PR5K
R47	Resistor, fixed, 10 kΩ, 1%, 1/4W	R2455	Pyrofilm PME60T9
R48	Resistor, fixed, 470 kΩ, 5%, 1/4W	02355250	AB
R49	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R50	Resistor, fixed, 15 kΩ, 5%, 1/4W	02354890	AB
R51	Resistor, fixed, 75k, 5%, 1/4W W	R0976 30	AB
R52	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R53	Resistor, fixed, 30.1kΩ, 1%, 1/4W	R2071	Electra MF5C-C-3012F
R54	Resistor, fixed, 68 kΩ, 2%, 1/4W	02397820	AB
R55	Resistor, fixed, 12 kΩ, 5%, 1/4W	02354870	AB
R56	Resistor, fixed, 62 kΩ, 5%, 1/4W	02355040	AB
R57	Resistor, fixed, 1 MΩ, 5%, 1/4W	02355330	AB
R58	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R59	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R60	Resistor, fixed, 68 kΩ, 5%, 1/4W	02355050	AB
R61	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R62	Resistor, fixed, 560kΩ, 5%, 1/4W	R1321	AB
R63	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R64	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R65	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R66	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R67	Resistor, fixed, 100Ω, 5%, 1/4W	02354380	AB
R68	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R69	Resistor, fixed, 47 kΩ, 5%, 1/4W	R0777	AB
R70	Resistor, fixed 470Ω, 5%, 1/4W	02354540	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R71	Resistor, fixed, 470 , 5%, 1/4W	02354540	AB
R72	Resistor, fixed, 120kΩ, 5%, 1/4W	R0807	AB
R73	Resistor, fixed, 12 kΩ, 5%, 1/4W	02354870	AB
R74	Resistor, fixed, 3.9 kΩ, 5%, 1/4W	02354750	AB
R75	Resistor, fixed, 10 kΩ, 1%, 1/4W	R2455	Pyrofilm PME60T9
R76	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R77	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R78	Resistor, fixed, 220kΩ, 5%, 1/4W	02355170	
R79	Resistor, fixed, 120kΩ, 5%, 1/4W	R0807	AB
R80	Resistor, fixed, 5.6kΩ, 5%, 1/4W	R0821	AB
R81	Resistor, fixed, 10kΩ, 1%, 1/4W	R2455	Pyrofilm PME60R9
R82	Resistor, fixed, 1MΩ, 5%, 1/4W	02355330	
R83	Resistor, fixed, 49.1Ω, 1%, .1W	R2673	
R84	Resistor, fixed, 100Ω, 1%, .1W	R2672	
R85	Resistor, fixed, 200Ω, 5%, .1W	R2671	
R86	Resistor, fixed, 24.9Ω, 1%, .1W	R2674	
R87	Resistor, fixed, 12.4Ω, 1%, .1W	R2675	
R88	Resistor, fixed, 6.19Ω, 1%, .1W	R2670	
R89	Resistor, fixed, 499Ω, 1%, 1/8W	R2647	
R90	Resistor, fixed, 1k, Potentiometer	01095400	

CIRCUIT DESCRIPTION
A7 INPUT AMPLIFIER & ACTIVE FILTER
SCHEMATIC #D37363A

The Input Amplifier Assembly A7 includes at its input Systron-Donner's patented three pole active filter. This filter is designed to have a corner frequency of 8. Hz and approximately 60 db per decade (or 36 db per octave) rolloff. This results in approximately 54 db of increased normal mode rejection at 60. Hz, with only a small decrease (on the order of 100. ms) in the effective rise time of the instrument.

In operation, ac signals appearing at the junction of C25 and C31 are passed through C25 to the input of integrated circuit amplifier, IC1 where they are amplified and inverted in phase and passed through C31 back to their point of origin. The original ac signal and the inverted and amplified signals then cancel at the junction of C25 and C31. The network consisting of R60, R61, and C28 add the additional phase shift around the amplifier, resulting in the effective third pole of filtering.

Input Amplifier

The input amplifier employs a packaged chopper stabilized operational amplifier followed by a high impedance output stage. to supply the charging current for the integrating capacitor. These amplifiers are powered by positive and negative supplies which are referenced to a floating ground, and this floating ground is connected to the signal common by the transconductance resistor which takes on the value of either 1.001 k ohms or 10.01 k ohms. Current in the output through the integrating capacitor has only the one path, the transconductance resistor, by which it is returned to the amplifier and its power supplies. The voltage developed in the transconductance resistor is negative current feedback. The output current takes on a value such that the voltage developed in the transconductance resistor is equal to the input voltage, and thus the output current is directly proportional to the input voltage. The high impedance output stage, A7(Q2,Q3,Q4, and Q5), provides isolation of the chopper stabilized stage and the active filter from the transients generated by the switching of the output current from the sink to the integrating capacitor at the various points in the measurement cycle.

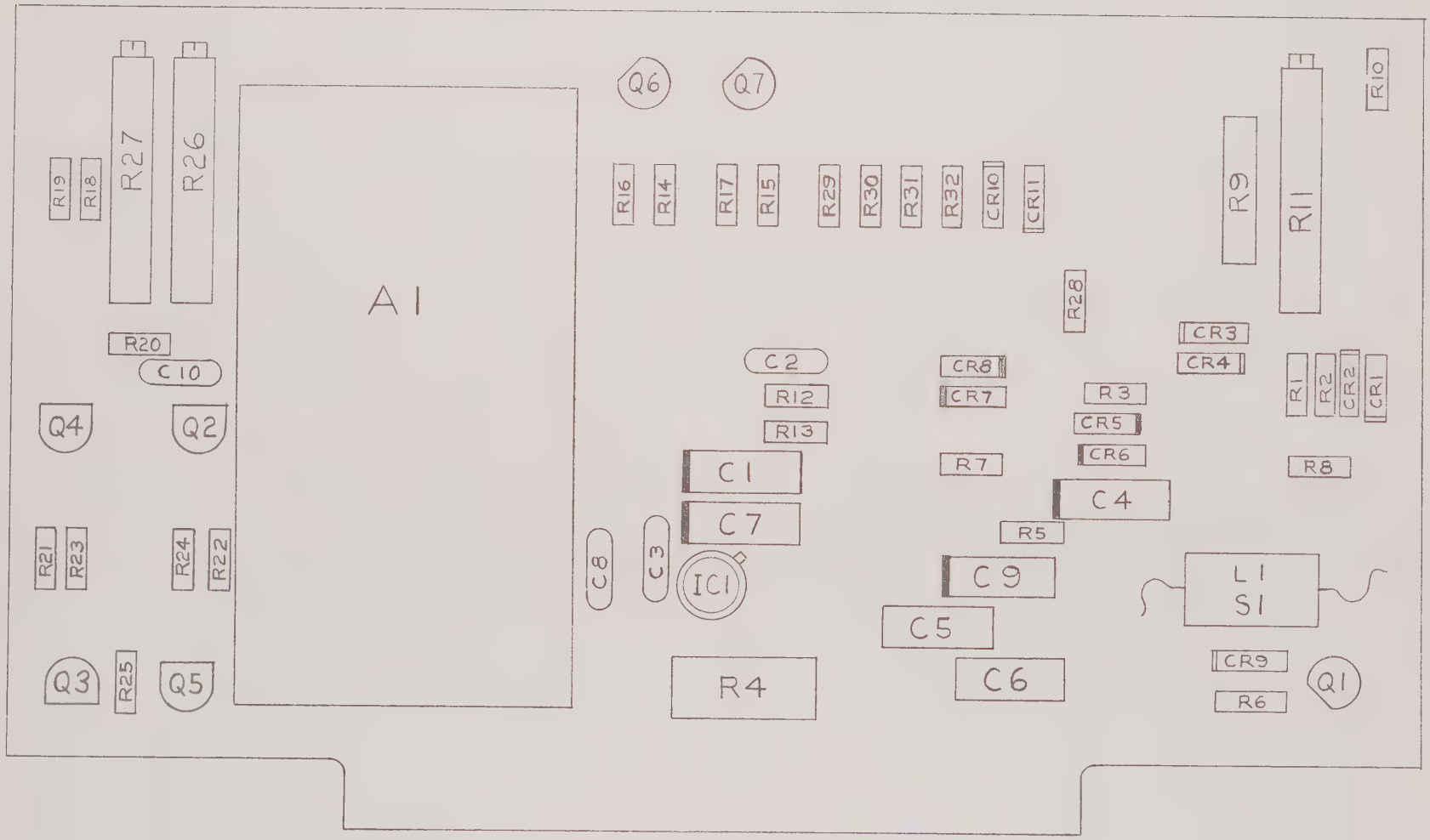
The full-scaled current required by the following circuitry is 1 mA, and the range is changed by shunting the 9.009 k ohm resistor, R11 with the low thermal EMF switch, S1. The 1.001 k ohm resistor is used on the 1 volt range and the 10.01 k ohm resistor is used on the 10 volt range.

The 15 V clamp in the input circuit of the amplifier protects it from damage due to overload. For small signal inputs the clamp has no effect on the amplifier input, because diodes CR3 and CR4 are reverse biased. For inputs with an amplitude in excess of +15 V, diodes CR6 and CR3 are forward biased and Zener diode CR2 clamps the input to +15 V (plus the small voltage drop across CR5 and CR4). When the input signal becomes more negative than -15 V. Resistor R3 provides a path for leakage current through CR4 and CR1 when they are reverse biased.

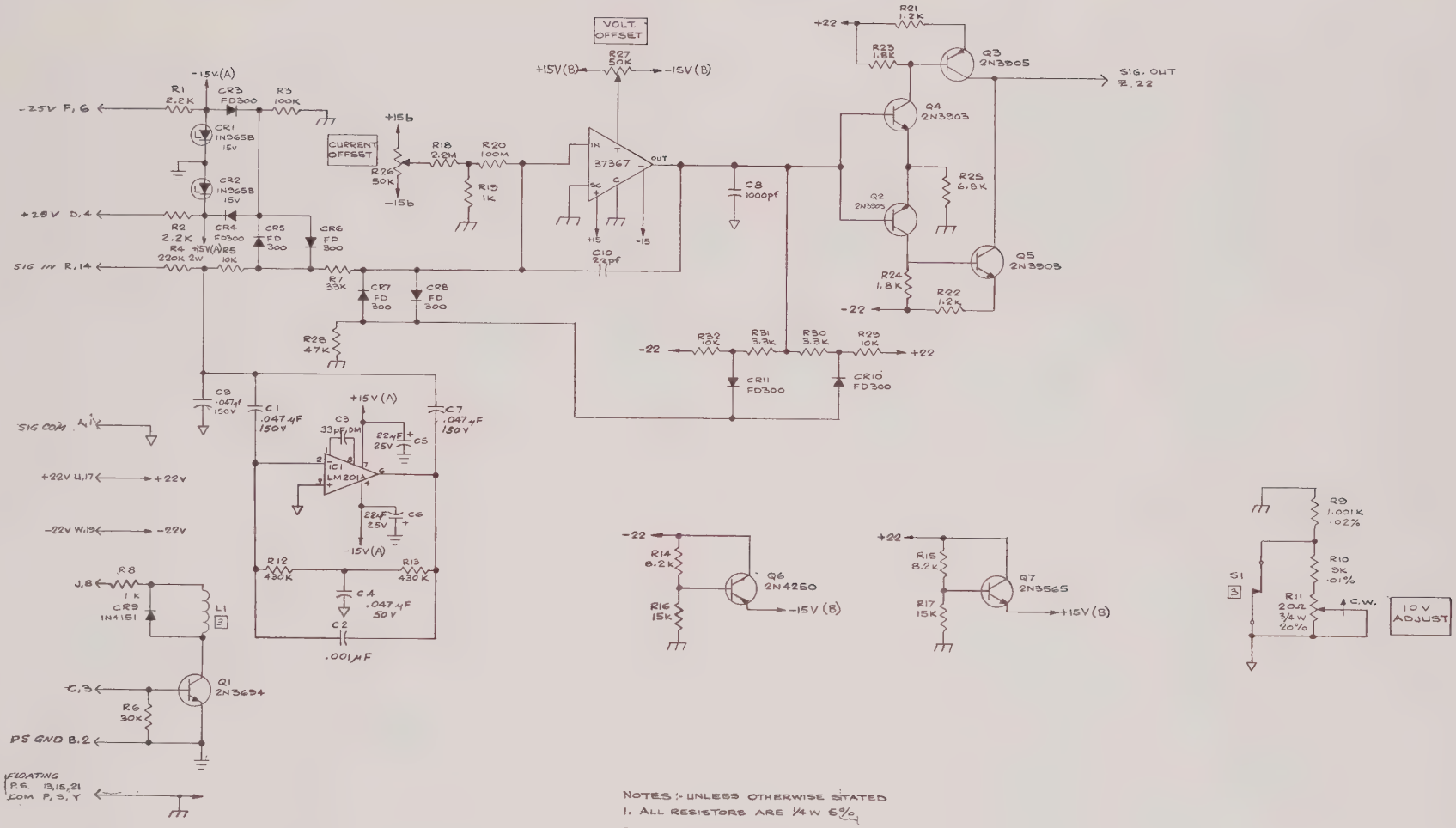
The clock then sends pulses to the counter until the charge on the integrating capacitor has gone through its excursion and returned to zero. At this time, the zero detector inhibits the clock. The clock remains inhibited until the start of the next measurement cycle.

During its operation, the clock output is taken from the collector of A6Q17 and applied through "AND" gate A6QA1A to the input of the first decade counter. When the voltage at the collector of A6Q17 goes high, the voltage at pin 7 of A6QA1A goes low; when A6Q17 collector voltage goes low, the voltage at pin 7 goes to +4 V. Thus, the clock output is a series of positive pulses occurring at a rate of 1.5 MHz.

In order to improve linearity of response for input voltages near zero and to remove the process of zero detection in time from that of switching from the integration of the input voltage to integration of the reference voltage, the detection voltage is set at a more positive voltage which corresponds to ten to twenty counts, and a connection is made from the flip-flop A6IC2A/B which stops the free running oscillator for the same number of counts when triggered by the Full Scale pulse. The offset adjustment for the zero detector is A6R44 ZERO ADJ and the elements in the oscillator which determine the length of shut down time are A6R29, A6CR(23,24), and A6C9.



A7 INPUT AMPLIFIER w/ACTIVE FILTER P.C. ASSEMBLY D37366E



NOTES :- UNLESS OTHERWISE STATED

1. ALL RESISTORS ARE 1/4W 5%

2.

3 L1 IS A COTO COIL, UD-32-P. IS1 IS A HAMLIN, MRM-F2 IN A SPECIAL LOW THERMAL, LOW VOLTAGE PACKAGE- ASSEMBLY B 37146

A7 INPUT AMPLIFIER w/ACTIVE FILTER SCHEMATIC D37363A

A7 INPUT AMPLIFIER ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, .047µF, 150V	C1241	
C2	Capacitor, fixed, .001µF, Disc	C0611	Erie 801-000-X5F0-10
C3	Capacitor, fixed, 33pF, DM	C0877	Elmenco DM-15E-330J
C4	Capacitor, fixed, .047µF, 50V	C1224	
C5	Capacitor, fixed, 22pF, 25V	C0371	Sprague 109D226X0025C2
C6	Capacitor, fixed, 22pF, 25V	C0371	Sprague 109D226X0025C2
C7	Capacitor, fixed, .047µF, 150V	C1241	
C8	Capacitor, fixed, 1000pF, DM	C0543	Elmenco DM-15F-102K-100
C9	Capacitor, fixed, .047µF, 150V	C1241	
C10	Capacitor, fixed, 22pF, DM	C0378	Elmenco DM15-C-2202-500
CR1	Diode, 1N965B	26014250	FSC
CR2	Diode, 1N965B	26014250	FSC
CR3	Diode, FD-300	26012320	FSC
CR4	Diode, FD-300	26012320	FSC
CR5	Diode, FD-300	26012320	FSC
CR6	Diode, FD-300	26012320	FSC
CR7	Diode, FD-300	26012320	FSC
CR8	Diode, FD-300	26012320	FSC
CR9	Diode, 1N4151	CR0150	FSC
CR10	Diode, FD-300	26012320	FSC
CR11	Diode, FD-300	26012320	FSC
Q1	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q2	Transistor, 2N3906	R0248	
Q3	Transistor, 2N3906	R0248	
Q4	Transistor, 2N3904	R0247	
Q5	Transistor, 2N3904	R0247	
Q6	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q7	Transistor, 2N3565	Q0237	
IC1	Integrated Circuit, LM201A	25758	SD
L1	Coil	B37146	
R1	Resistor, fixed, 2.2kΩ, 5%, 1/4W	R0937	
R2	Resistor, fixed, 2.21Ω, 5%, 1/4W	R0937	
R3	Resistor, fixed, 10kΩ, 5%, 1/4W	02355090	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R4	Resistor, fixed, 220kΩ, 5%, 1/4W	02037040	AB
R5	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	AB
R6	Resistor, fixed, 30kΩ, 5%, 1/4W	02354960	
R7	Resistor, fixed, 33kΩ, 5%, 1/4W	R0780	AB
R8	Resistor, fixed, 1kΩ, 5%, 1/4W	R0765	AB
R9	Resistor, fixed, 1.001kΩ, .02%, 2ppm	02392071	
R10	Resistor, fixed, 9kΩ, 5%, 1/4W	02398640	
R11	Resistor, fixed, 20Ω, Potentiometer	R2603	Helipot 78PR 20 ohm
R12	Resistor, fixed, 430kΩ, 5%, 1/4W	R1586	AB
R13	Resistor, fixed, 430kΩ, 5%, 1/4W	R1586	AB
R14	Resistor, fixed, 8.2kΩ, 5%, 1/4W	R0883	AB
R15	Resistor, fixed, 8.2kΩ, 5%, 1/4W	R0883	AB
R16	Resistor, fixed, 15kΩ, 5%, 1/4W	R0728	AB
R17	Resistor, fixed, 15kΩ, 5%, 1/4W	R0728	AB
R18	Resistor, fixed, 2.2MΩ, 5%, 1/4W	R1014	AB
R19	Resistor, fixed, 1kΩ, 5%, 1/4W	R0765	AB
R20	Resistor, fixed, 100MΩ, 5%, 1/4W	R2557	AB
R21	Resistor, fixed, 1.2kΩ, 5% 1/4W	R0809	AB
R22	Resistor, fixed, 1.2kΩ, 5%, 1/4W	R0809	AB
R23	Resistor, fixed, 1.8kΩ, 5%, 1/4W	R0959	AB
R24	Resistor, fixed, 1.8kΩ, 5%, 1/4W	R0959	AB
R25	Resistor, fixed, 4.7kΩ, 5%, 1/4W	R0892	AB
R26	Resistor, fixed, 50kΩ, 5%, 1/4W	01110320	
R27	Resistor, fixed, 50kΩ, 5%, 1/4W	01110320	
R28	Resistor, fixed, 47kΩ, 5%, 1/4W	R0777	AB
R29	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	
R30	Resistor, fixed, 3.3kΩ, 5%, 1/4W	R2742	
R31	Resistor, fixed, 3.3kΩ, 5%, 1/4W	R2742	
R32	Resistor, fixed, 10kΩ, 5%, 1/4W	02354850	
S1	Switch, reed	B37146	
	Miscellaneous		
	Transistor Pad (TO-5)	41012340	Transipad 10028-DAP
	Shield, reed switch	42025811	SD
	Shield, amplifier	64020021	SD
	Staple	09045172	SD

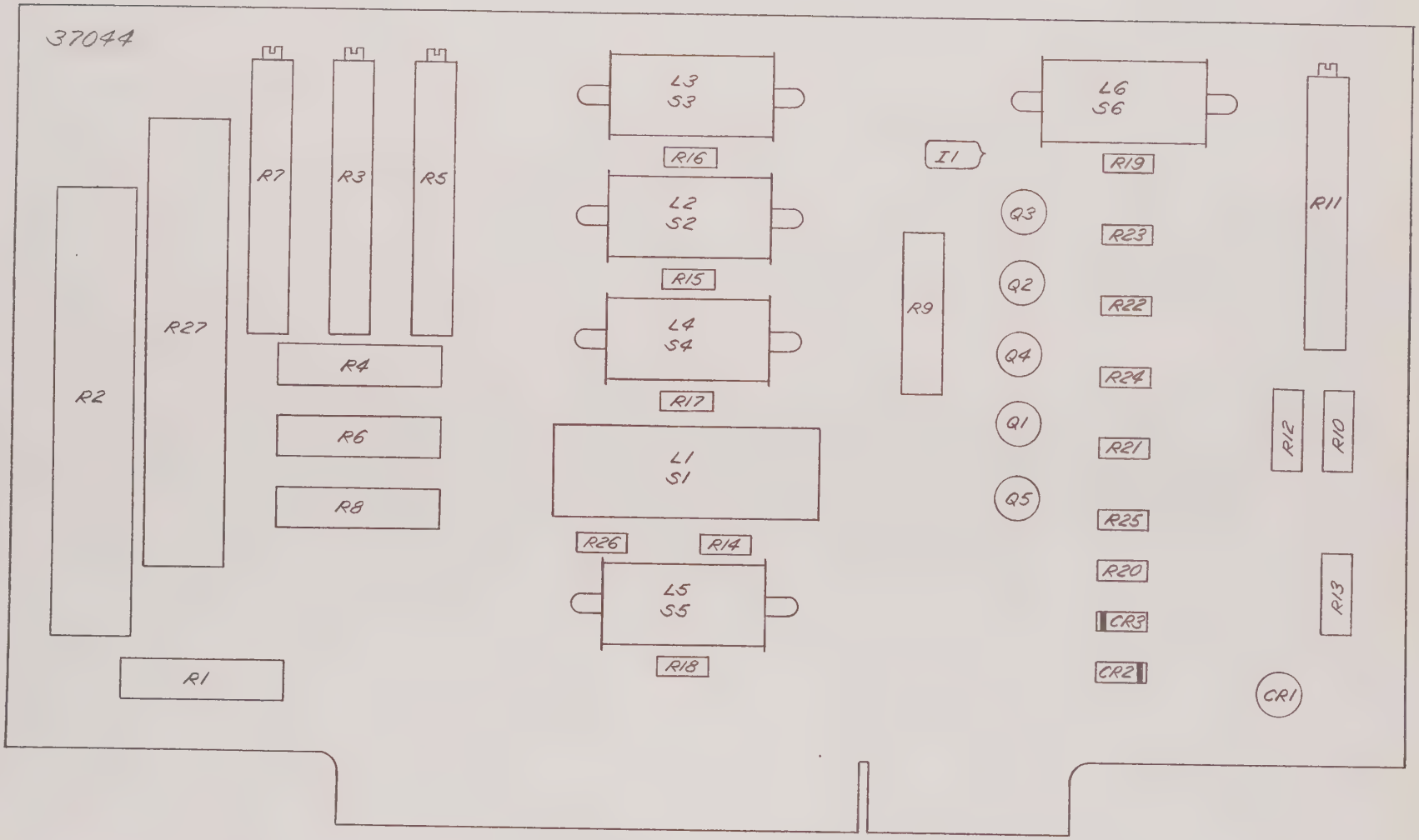
CIRCUIT DESCRIPTION
A8 DC ATTENUATOR
SCHEMATIC #D37042B

The A8 DC Attenuator acts as the voltage divider for the 100 and 1000 VDC ranges, the resistance measurement test current resistor string, the test function supply, and the overload protection circuitry.

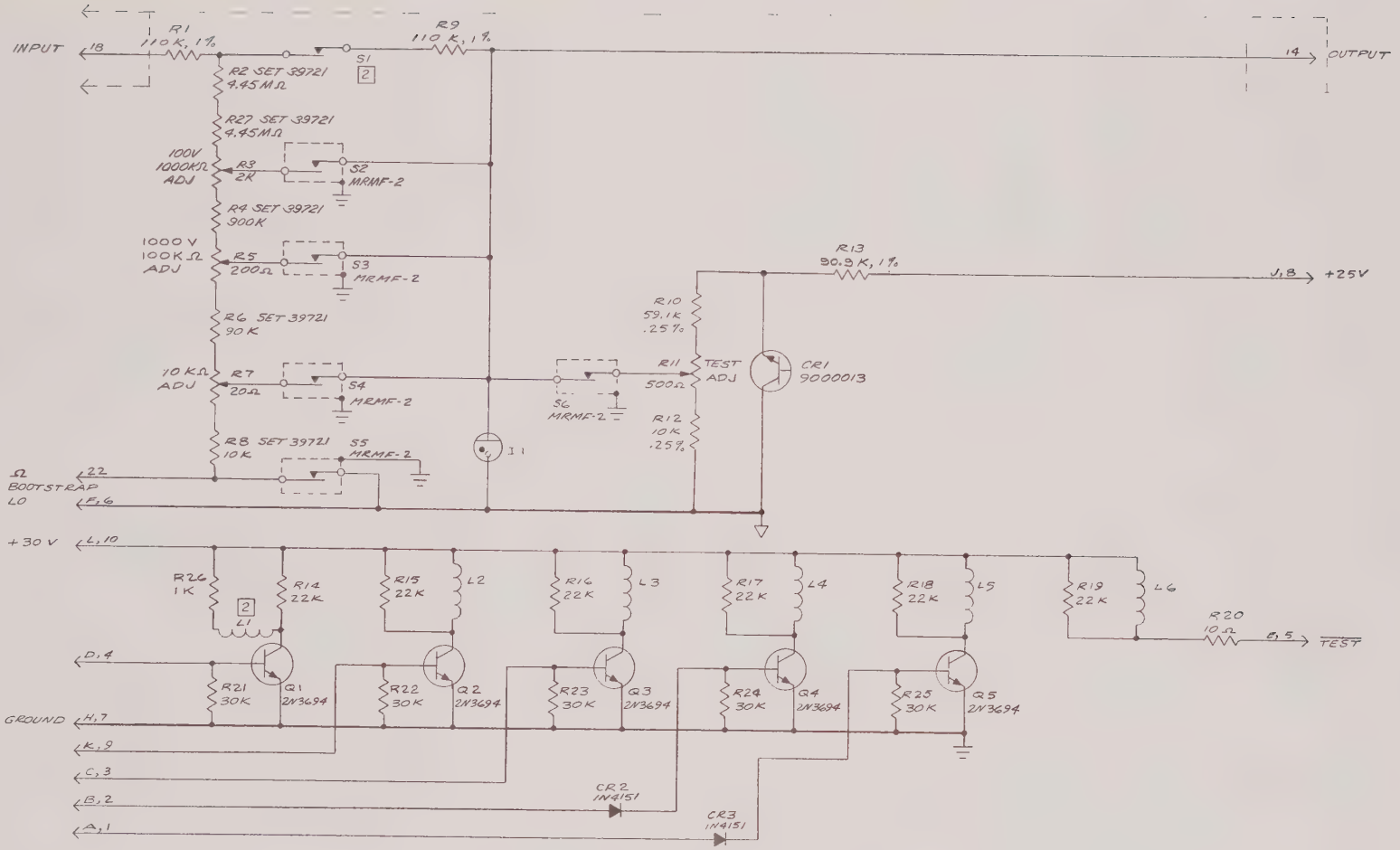
For voltage measurements in the 1 and 10 V ranges, S1 only is closed. This connects the input voltage through protection components R1, R9, and I1 to the input amplifier. For the higher ranges, S5 is closed, connecting the divider into the circuit. S2 provides a 10:1 division for the 100 VDC range, and S3 provides 100:1 division for the 1000 VDC range.

For resistance measurements, 10 V is impressed across the resistor string by the ohms converter board. R1, 2, 27, 3, and 4 therefore provide a current source of 1, 10, 100, and 1000 µA to the input terminals.

The test function circuitry consists of CR1, a 6.8 V zener and a divider to provide 1 V to the input amplifier through S6.



A8 DC ATTENUATOR P.C. ASSEMBLY D37045F



NOTE:

1. UNLESS OTHERWISE SPECIFIED RESISTORS ARE 5%, 1/4W

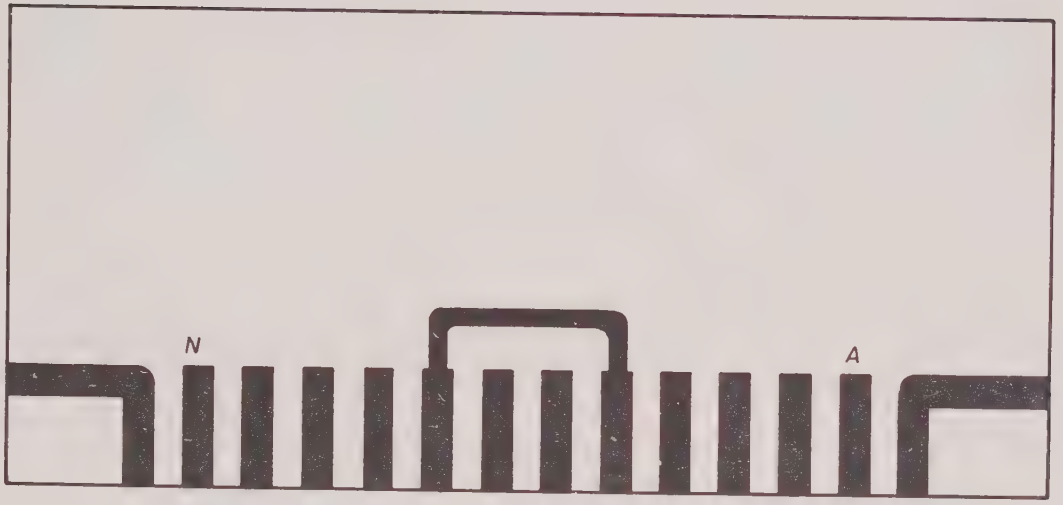
[2] L1 IS COTO COIL UD-32-P, SI 15 GORDO MR338 IN A SPECIAL LOW THERMAL, HIGH VOLTAGE PACKAGE - ASSEMBLY DWG B37368

A8 DC ATTENUATOR SCHEMATIC D37042E

A8 DC ATTENUATOR ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
CR1	Diode, Special	90000013	SD
CR2	Diode, IN4151	CR0150	FSC
CR3	Diode, IN4151	CR0150	FSC
I1	Lamp	I0086	Laminated Prod. Type 95
L2	Coil, reed relay	21103130	Coto U32P
L3	Coil, reed relay	21103130	Coto U32P
L4	Coil, reed relay	21103130	Coto U32P
L5	Coil, reed relay	21103130	Coto U32P
L6	Coil, reed relay	21103130	Coto U32P
R1	Resistor, fixed, 110 kΩ, 1%	R2600	Jeffers JXP-70
R2	Resistor Set, precision, matched 39721	39721	SD
R3	Resistor, variable, 2 kΩ	R2270	Beckman 78PR2K
R4	Resistor Set, precision, matched P/O 39721 set		
R5	Resistor, variable, 200Ω	R2215	Beckman 78PR200
R6	Resistor Set, precision, matched P/O 39721 set		
R7	Resistor, variable, 20Ω	R2603	Beckman 78PR20
R8	Resistor Set, precision, matched P/O 39721 set		
R9	Resistor, fixed, 110 kΩ, 1%	R2600	Jeffers JXP-70
R10	Resistor, fixed, 59.1 kΩ, .25%	R2599	
R11	Resistor, Variable, 500Ω, 22-turn	0110250	Beckman 78P
R12	Resistor, fixed, 10 kΩ, .25%, 1/8W	02399360	Dale RN60E
R13	Resistor, fixed, 90.9 kΩ, 1%	R2601	
R14	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R15	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R16	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R17	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R18	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R19	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R20	Resistor, fixed, 10Ω, 5%, 1/4W	02354140	AB
R21	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R22	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R23	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R24	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R25	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R26	Resistor, fixed, 1kΩ, 5%, 1/4W	R0765	AB
S2	Switch, reed	05036220	Hamlin MRMF-2
S3	Switch, reed	05036220	Hamlin MRMF-2
S4	Switch, reed	05036220	Hamlin MRMF-2
S5	Switch, reed	05036220	Hamlin MRMF-2
S6	Switch, reed	05036220	Hamlin MRMF-2
	Shield, reed relay (S2 thru S6)	42025811	SD
Q1	Transistor, 2N3694	26012660	
Q2	Transistor, 2N3694	26012660	
Q3	Transistor, 2N3694	26012660	
Q4	Transistor, 2N3694	26012660	
Q5	Transistor, 2N3694	26012660	



NOTE

A11 is a jumper board which is included only when neither the Current Shunt Assembly (Option 04) nor the Preamplifier Assembly (Option 07) is included.

Jumper Board Assembly A11

CIRCUIT DESCRIPTION
A12 POWER SUPPLY REGULATOR
SCHEMATIC #D9300012P

Power supply voltages are obtained from regulators mounted on board A12. Supply voltages are +30V, +12 V, ±25 V, +4 V and ±22 V floating.

±22V Floating Supply

The floating ±22 V supply is used with the input amplifier exclusively. The ground reference of the supply is isolated from the main circuit common (LO). Regulation of the -22 V output is controlled by series regulator A12Q19.

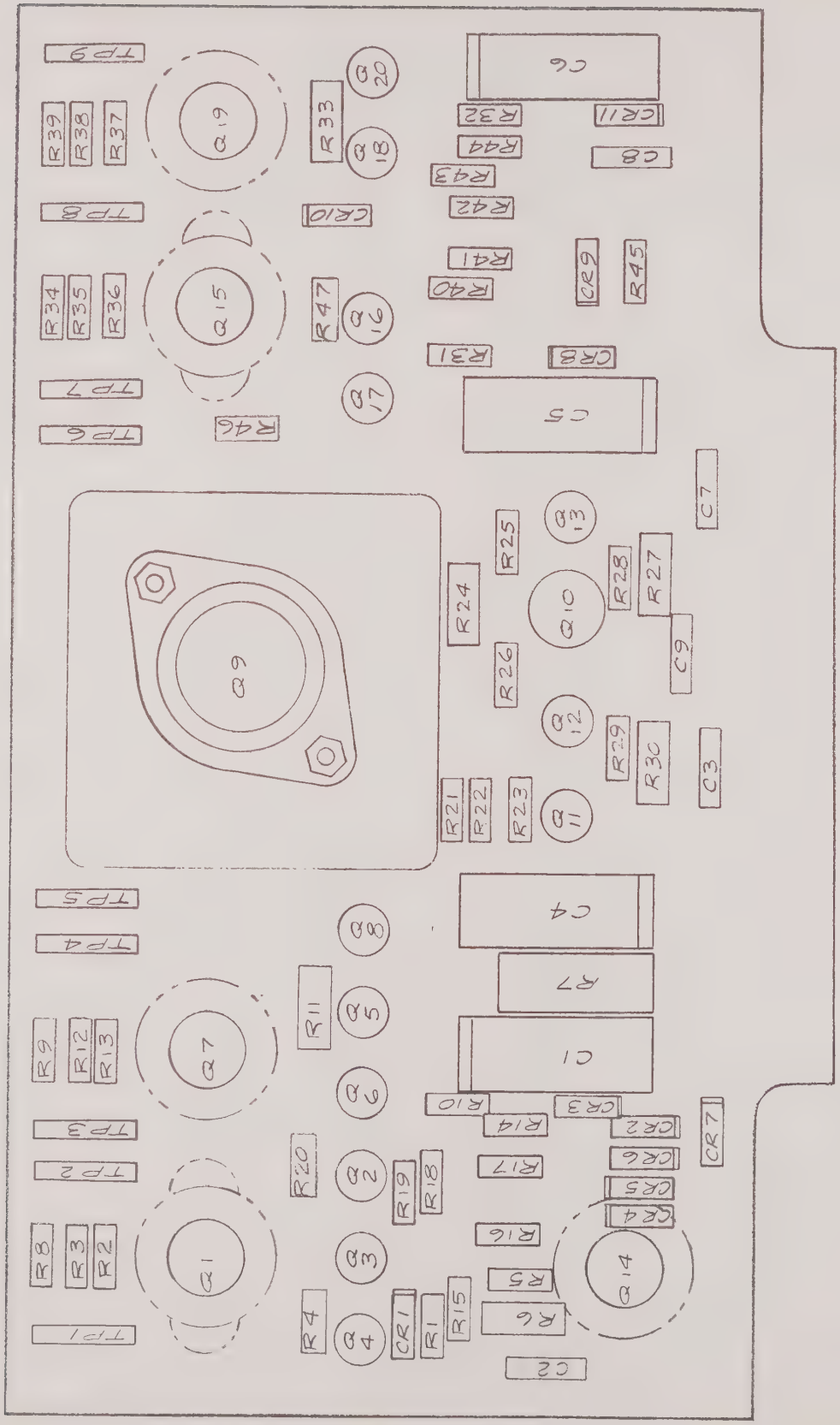
Reference is established by zener diode A12CR10. The -22 V output is sensed across resistors A12R40 through A12R43, and the output variation is detected at the base of A12Q18. The emitter of A12Q18 is held at a fixed reference potential by zener diode A12CR10. The output at the collector of A12Q18 controls series regulator A12Q19. Regulation is accomplished as follows: An increase in current load causes a tendency to lower the output voltage. The slight voltage drop is sensed at the base of A12Q18 making it conduct less. This allows more base current to flow into Q19 causing it to conduct harder to compensate for the voltage drop. Resistor A12R33 shares the load current with series regulator A12Q19. Transistor A12Q20 and resistor A12R39 act together to provide short circuit protection. Output current flows through A12R39 and when the current becomes too large, the drop across A12R39 is sufficient to turn A12Q20 on. This turns the series regulator off. Capacitor A12C8 acts as a filter to reduce ripple at the output of the supply. Resistor A12R32 and A12CR11 provide a load path for A12Q18. Capacitor A12C6 reduces ripple at the input of the regulator. The jumpers across A12R41 and A12R42 are factory preset to set the output to -22 V.

The +22 V circuit is referenced to the -22 V supply and operates in a similar manner.

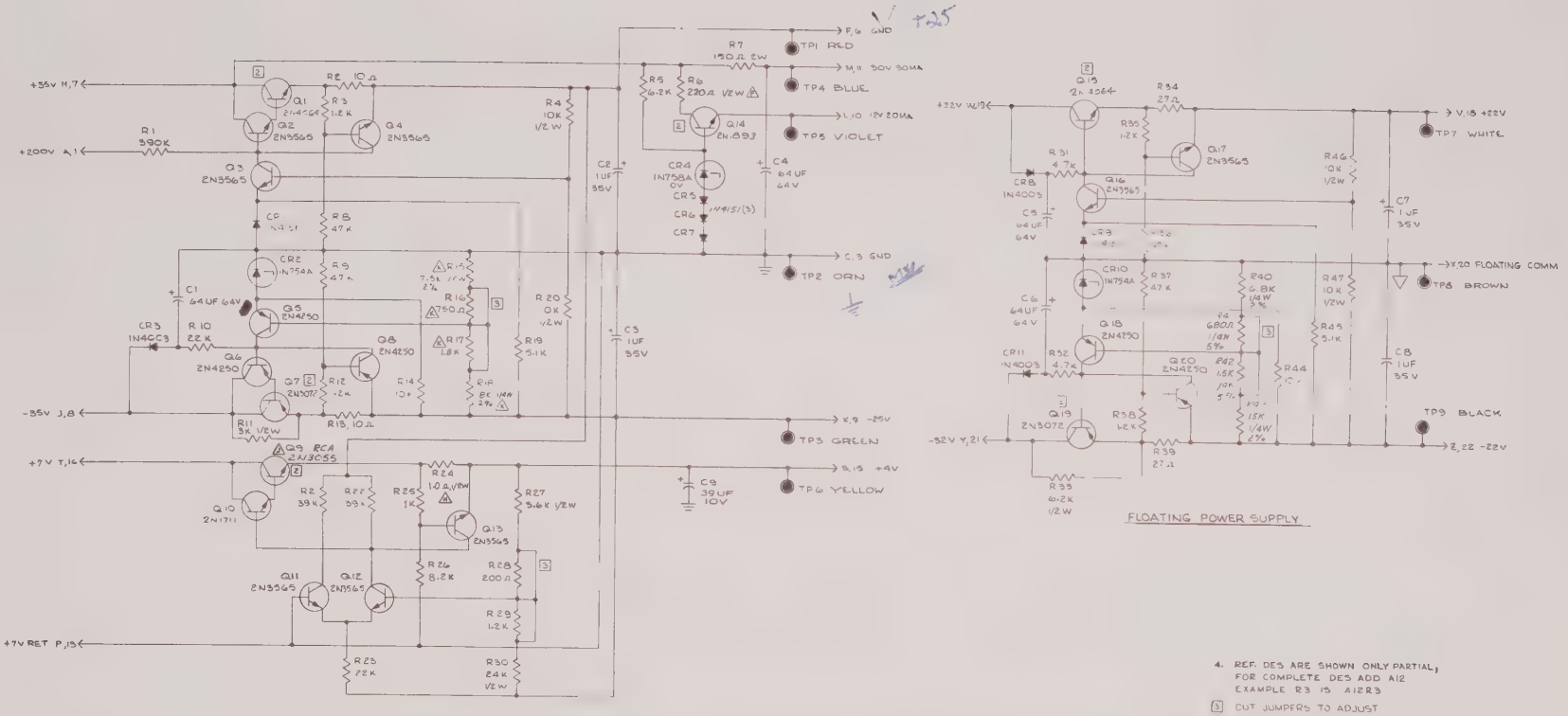
+30 V, +12 V, ±25 V Power Supplies

The +30 V supply is capable of delivering 30 mA and its main function is to provide relay driving power. Resistor A12 R7 and capacitor A12 C4 comprise a simple filter network to reduce ripple in the +30 V output.

The +12 V and ±25 V outputs are used to provide circuit levels for V_{CC}, etc. The +12 V supply employs series regulator A12Q14 and reference zener diode A12CR4 to accomplish regulation. Diodes A12CR5, A12CR6, A12CR7 provide additional voltage offset to accomplish the +12 V output. Regulation of the +25 V supply is referenced to the -25 V output.



A12 POWER REGULATOR P.C. ASSEMBLY D93000112Q



4. REF. DES ARE SHOWN ONLY PARTIAL, FOR COMPLETE DES ADD A12 EXAMPLE R3 IS A12R3

[3] CUT JUMPERS TO ADJUST

[2] USE WITH HEATSINK

1. ALL RESISTORS ARE 1/4 W 5%

NOTES: UNLESS OTHERWISE SPECIFIED

A12 POWER REGULATOR SCHEMATIC D93000112P

A12 POWER SUPPLY REGULATOR ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, 64μF, 64V	03286620	Amperex C437AR/H64
C2	Capacitor, fixed, 1μF, 35V	03279130	Fansteel
C3	Capacitor, fixed, 1μF, 35V	03279130	Fansteel
C4	Capacitor, fixed, 64μF, 64V	03286620	Amperex C437AR/H64
C5	Capacitor, fixed, 64μF, 64V	03286620	Amperex C437AR/H64
C6	Capacitor, fixed, 64μF, 64V	03286620	Amperex C437AR/H64
C7	Capacitor, fixed, 1μF, 35V	03279130	Fansteel
C8	Capacitor, fixed, 1μF, 35V	03279130	Fansteel
C9	Capacitor, 39μF, 10V	03287630	Sprague 150D396X9010B2
CR1	Diode, FD100	26006930	FSC DXA1100801
CR2	Diode, IN754A	26014220	FSC
CR3	Diode, IN4003	26011080	FSC
CR4	Diode, IN758A	26012550	FSC
CR5	Diode, FD100	26006930	FSC DXA1100801
CR6	Diode, FD100	26006930	FSC DXA1100801
CR7	Diode, FD100	26006930	FSC DXA1100801
CR8	Diode, IN4003	26011080	FSC
CR9	Diode, FD100	26006930	FSC DXA1100801
CR10	Diode, IN754A	26014220	FSC
CR11	Diode, IN4003	26011080	FSC
Q1	Transistor, 2N4064	Q0294	RCA 40256
Q2	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q3	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q4	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q5	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q6	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q7	Transistor, 2N3072	26008560	FSC TXC3517HCF
Q8	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q9	Transistor, 2N3055	26012140	RCA
Q10	Transistor, 2N1711	26007450	FSC
Q11	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q12	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q13	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q14	Transistor, 2N1893	26007250	FSC
Q15	Transistor, 2N4064	Q0294	RCA 40256
Q16	Transistor, 2N3656	26012000	FSC TXY1250EBX
Q17	Transistor, 2N3656	26012000	FSC TXY1250EBX

Ref.	Description	SD Part No.	Manufacturers Part No.
Q18	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q19	Transistor, 2N3072	26008560	FSC TXC3517HCF
Q20	Transistor, 2N4250	26014430	FSC TXY0019ELA
R1	Resistor, fixed, 390 kΩ, 5%, 1/4W	02355230	AB
R2	Resistor, fixed, 10Ω, 5%, 1/4W	02354140	AB
R3	Resistor, fixed, 1.2 kΩ, 5%, 1/4W	02354640	AB
R4	Resistor, fixed, 10 kΩ, 5%, 1/2W	02030720	AB
R5	Resistor, fixed, 6.2 kΩ, 5%, 1/4W	02354830	AB
R6	Resistor, fixed, 270Ω, 5%, 1/2W	0203340	AB
R7	Resistor, fixed, 150Ω, 5%, 2W	02036280	AB
R8	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R9	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R10	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R11	Resistor, fixed, 3.0 kΩ, 5%, 1/2W	02030590	AB
R12	Resistor, fixed, 1.2 kΩ, 5%, 1/4W	02354640	AB
R13	Resistor, fixed, 10Ω, 5%, 1/4W	02354140	AB
R14	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R15	Resistor, fixed, 7.5 kΩ, 2%, 1/4W	02397590	Corning C4
R16	Resistor, fixed, 750Ω, 5%, 1/4W	02354590	AB
R17	Resistor, fixed, 1.8 kΩ, 5%, 1/4W	02354670	AB
R18	Resistor, fixed, 18 kΩ, 5%, 1/4W	02397680	AB
R19	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R20	Resistor, fixed, 10 kΩ, 5%, 1/2W	02030720	AB
R21	Resistor, fixed, 39 kΩ, 5%, 1/4W	02354990	AB
R22	Resistor, fixed, 39 kΩ, 5%, 1/4W	02354990	AB
R23	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R24	Resistor, fixed, 1.0Ω, 5%, 1/2W	02420690	AB
R25	Resistor, fixed, 1.0 kΩ, 5%, 1/4W	02354620	AB
R26	Resistor, fixed, 8.2 kΩ, 5%, 1/4W	02354830	AB
R27	Resistor, fixed, 3.6 kΩ, 5%, 1/2W	02030610	AB
R28	Resistor, fixed, 200Ω, 5%, 1/4W	02354450	AB
R29	Resistor, fixed, 1.2 kΩ, 5%, 1/4W	02354640	AB
R30	Resistor, fixed, 24 kΩ, 5%, 1/2W	02030810	AB
R31	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R32	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R33	Resistor, fixed, 6.2 kΩ, 5%, 1/2W	02030670	AB
R34	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354240	AB
R35	Resistor, fixed, 1.2 kΩ, 5%, 1/4W	02354640	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R36	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R37	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R38	Resistor, fixed, 1.2 kΩ, 5%, 1/4W	02354640	AB
R39	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354240	AB
R40	Resistor, fixed, 6.8 kΩ, 2%, 1/4W	02397580	Corning C4
R41	Resistor, fixed, 680Ω, 5%, 1/4W	02554589	AB
R42	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R43	Resistor, fixed, 15 kΩ, 2%, 1/4W	02397660	AB
R44	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R45	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R46	Resistor, fixed, 10 kΩ, 5%, 1/2W	02030720	AB
R47	Resistor, fixed, 10 kΩ, 5%, 1/2W	02030720	AB
TP1	Test Jack, red	09063120	Carter
TP2	Test Jack, orange	09063130	Carter
TP3	Test Jack, green	09063150	Carter
TP4	Test Jack, blue	09063160	Carter
TP5	Test Jack, violet	09063170	Carter
TP6	Test Jack, yellow	09063140	Carter
TP7	Test Jack, white	09063190	Carter
TP8	Test Jack, brown	09063110	Carter
TP9	Test Jack, black	09063100	Carter
XQ1	Heat Sink	27004480	
XQ2	Not Used		
XQ3	Not Used		
XQ4	Not Used		
XQ5	Not Used		
XQ6	Not Used		
XQ7	Heat Sink	27004480	
	Transipad	41012340	
XQ8	Not Used		
XQ9	Heat Sink	27004470	
XQ10	Heat Sink	27004470	
XQ11	Heat Sink	27004470	
XQ12	Heat Sink	27004470	
XQ13	Not Used		
XQ14	Heat Sink	27004480	
XQ15	Heat Sink	27004360	Wakefield

Ref.	Description	SD Part No.	Manufacturers Part No.
XQ16	Not Used		
XQ17	Not Used		
XQ18	Not Used		
XQ19	Heat Sink	27004360	Wakefield NF205
	Transipad	41012340	

CHAPTER 7
OPTION CIRCUIT DESCRIPTIONS, DRAWINGS, AND PARTS LISTS

7.1 INTRODUCTION

This chapter contains circuit descriptions, drawings, and parts lists for options which may be added to the standard unit to tailor it for a specific need. The options are in numerical sequence with the assembly designator in parenthesis. Special options may be requested and will be described in this section as needed.

CIRCUIT DESCRIPTION
OPTION 01 (A1) AUTOMATIC RANGING
SCHEMATIC #D93000184F

Instrument ranging is automatic on all measurement modes of operation when the auto-ranging plug-in Option 01 is fitted. The ranging process occurs only when the input signal changes in amplitude and falls outside the prescribed limits of the range in use. These limits are 12000 and 00980. The instrument ranges up or down, according to the direction of the level change, until the correct range is found. In the absence of an input, the meter drops to the lowest range.

Basic range data is generated by a reversible ring counter with five output lines, each corresponding to a range. (A ring counter is a loop of interconnected elements, any one of which is in a specified state at any one time. Each time an input pulse is applied, the specified state advances one position in an ordered sequence around the loop. A reversible counter has two inputs-one moves the ordered sequence in one direction around the loop; the other moves it in the opposite direction.) The two inputs to the ring counter, designated up range and down range, are derived from the logic of the system decade counter. In brief this circuit:

a) Produces an up range pulse when the counter reaches 12000. (This is also a range overload condition and is detected by the overload logic.)

b) Produces a down range pulse when the zero detector reaches null befrre the readout exceeds 00980. This is a range condition where the readout can be given with better resolution on a lower range.

Figures 4-17 and 4-18 show circuit timing. Each time the counter reaches 12000, the JK complementing flip-flop element A4QA3 is triggered. The output at pin 5 is coupled to AND gate A4QA2B. The dotted lines at the right of figure 4-17 show the instrument in the correct range; the solid lines indicate production of an up range pulse.

Generation of the down range pulse is derived from AND gate A4QA2A. AND gate A4QA2A compares the output of flip-flop A4QA6A/B and the ZERO DET signal. Output of the flip-flop is low from full scale to 00980 and if null is detected during this time a down range pulse is generated. The basence of a ZERO DET signal during the same period prevents generation of the down range pulse. The dotted lines in figure 4-18 show circuit operation when the down range is not produced; the solid lines show production of the pulse.

Ring Counter

Operation of the ring counter is such that at any one time, all stages in the counter are on except one; it is held off. Assume an initial condition with A4Q3 off. In this condition, decimal point driver A4Q8 is turned on and the visual range indication is given as XXX.XX. The positive voltage at the collector of A4Q3 deposits a charge on A4C70 and A4C10. A4C70 is used in up ranging; A4C10 in down ranging. The collectors of transistors A4Q1, A4Q2, A4Q4 and A4Q5 are held to ground when A4Q4 is off.

When an up range pulse (the negative going trailing edge is used to trigger the counter) is applied to the ring counter, the negative pulse is passed by steering diodes A4CR3, C4CR4, A4CR5, A4CR6 and transmitted across the input capacitors to the bases of their respective transistors. Momentarily all of the stages are driven off. Due to the preset charge on A4C70, A4Q4 is driven further off than the other stages. A4Q3 is driven on as the voltage rise at the collector of A4Q4 is transmitted via A4-CR17 to the base of A4Q3. Similar action also holds all of the other stages on. The new decimal point location is XXX.X.

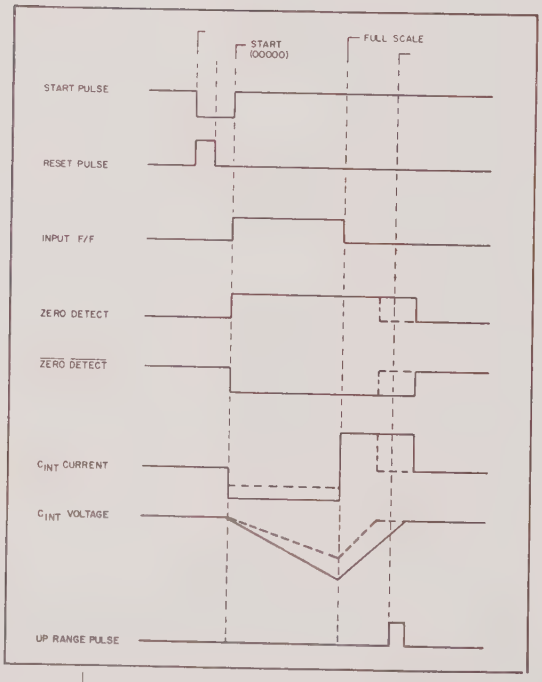


Figure A. Up-Range Pulse

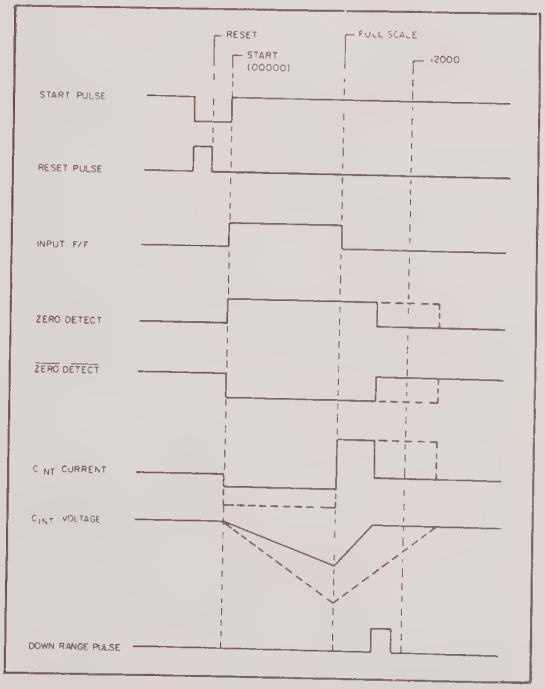
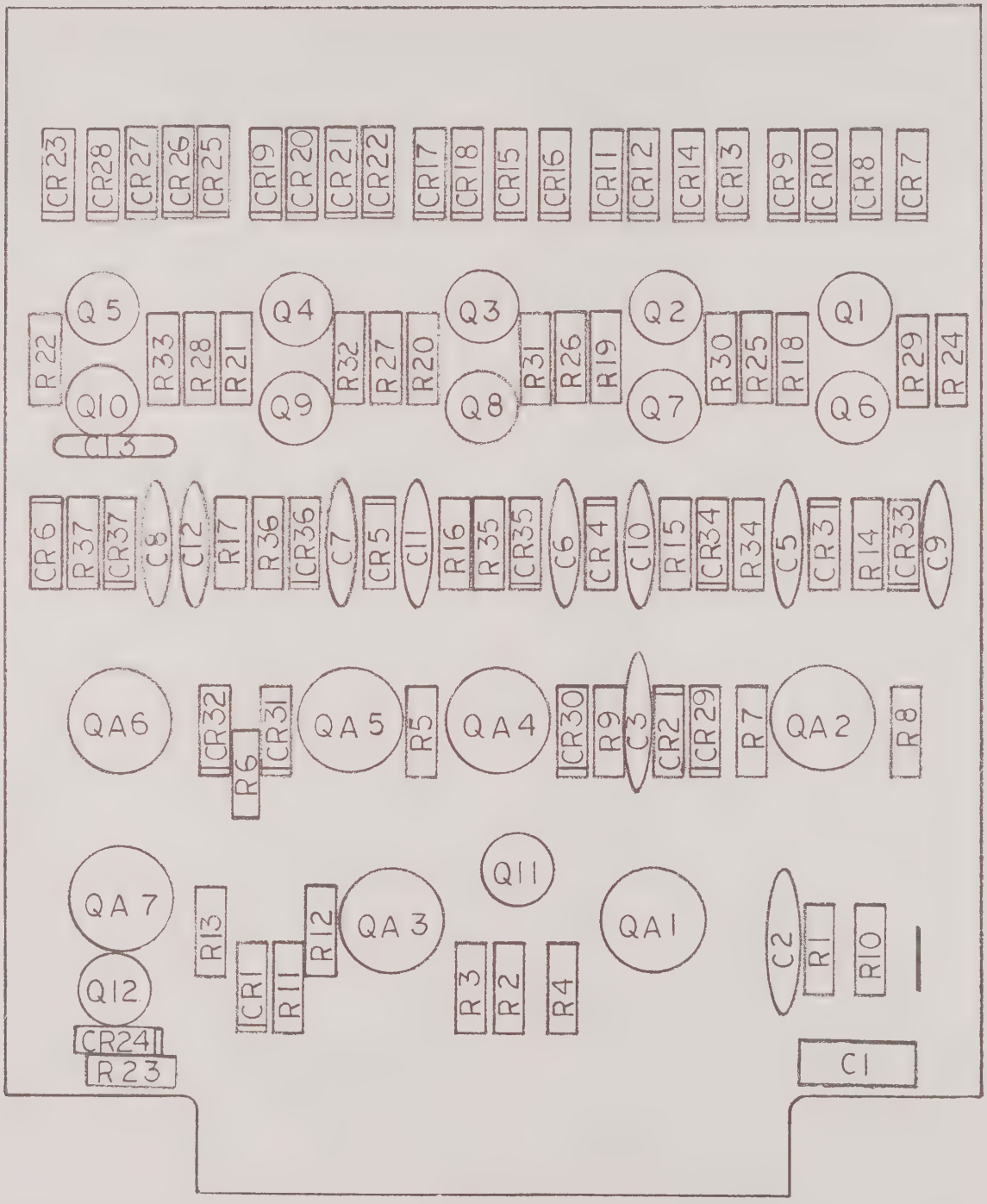
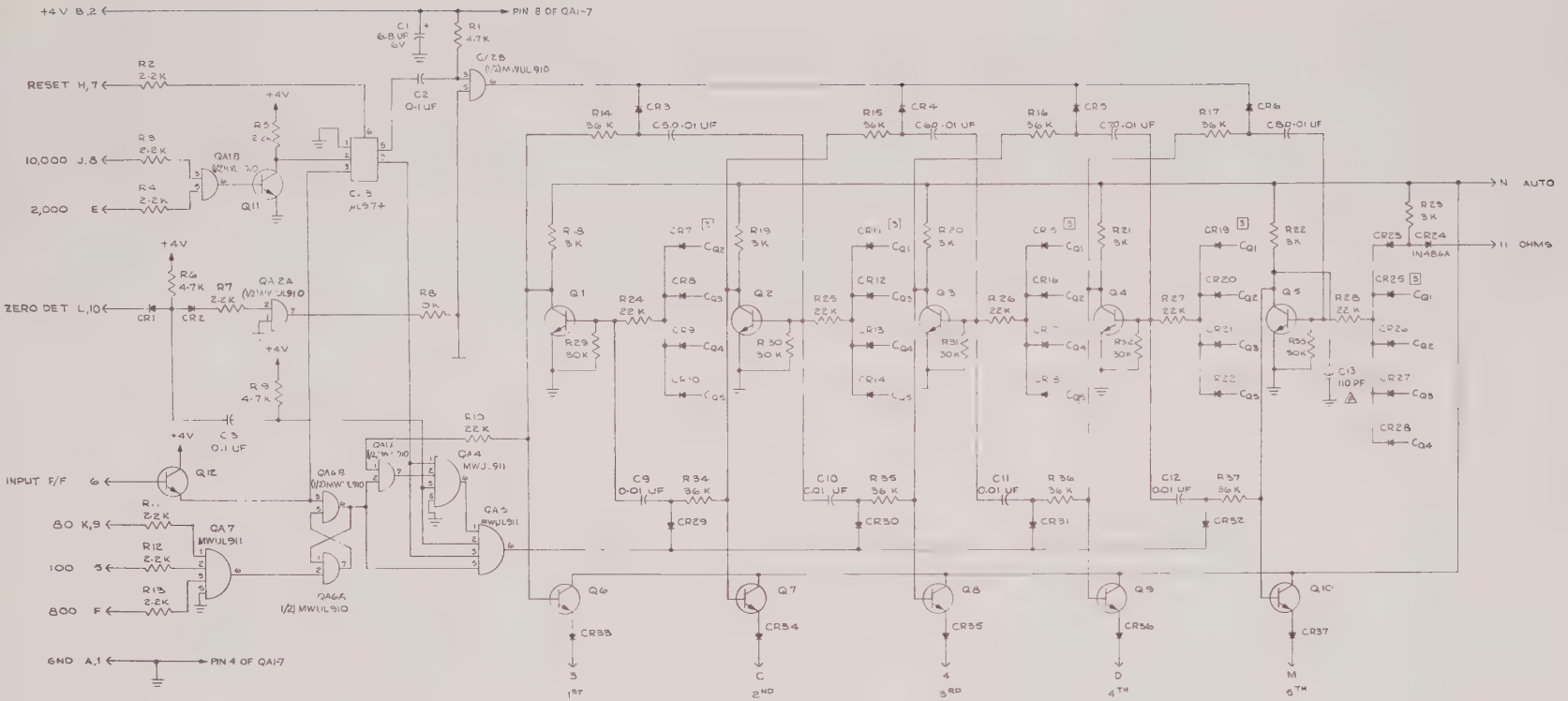


Figure B. Down-Range Pulse



OPTION 01 (A4) AUTO RANGE P.C. ASSEMBLY C93000184F



5. REF DES ARE SHOWN ONLY PARTIAL, FOR COMPLETE DES ADD A4 EXAMPLE R3 IS A4R3.
4. ALL RESISTORS ARE 1/4W, 5%
3. C_{QX} = COLLECTOR RING COUNTER FEED BACK
2. Q1-Q12 ARE 2N3563
1. CR1-CR23 & 25-37 ARE FD100

NOTES: UNLESS OTHERWISE SPECIFIED

OPTION 01 (A4) AUTO RANGE SCHEMATIC D93000184F

OPTION 01 (A4) AUTORANGE ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, 6.8µF, 6V	03280370	Sprague 150D685X9006A2
C2	Capacitor, fixed, .1µF, 100V	03289110	Westcap 4M1104M
C3	Capacitor, fixed, .1µF, 100V	03289110	Westcap 4M1104M
C4	Not Used		
C5	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C6	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C7	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C8	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C9	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C10	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C11	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C12	Capacitor, fixed, .01µF, 200V	C0562	Sprague 5C023105X025083
C13	Capacitor, fixed, 110pF, 500V	03281330	Elmenco DM15-111J
CR1	Diode, FD100	26006930	FSC
CR2	Diode, FD100	26006930	FSC
CR3	Diode, FD100	26006930	FSC
CR4	Diode, FD100	26006930	FSC
CR5	Diode, FD100	26006930	FSC
CR6	Diode, FD100	26006930	FSC
CR7	Diode, FD100	26006930	FSC
CR8	Diode, FD100	26006930	FSC
CR9	Diode, FD100	26006930	FSC
CR10	Diode, FD100	26006930	FSC
CR11	Diode, FD100	26006930	FSC
CR12	Diode, FD100	26006930	FSC
CR13	Diode, FD100	26006930	FSC
CR14	Diode, FD100	26006930	FSC
CR15	Diode, FD100	26006930	FSC
CR16	Diode, FD100	26006930	FSC
CR17	Diode, FD100	26006930	FSC
CR18	Diode, FD100	26006930	FSC
CR19	Diode, FD100	26006930	FSC
CR20	Diode, FD100	26006930	FSC
CR21	Diode, FD100	26006930	FSC
CR22	Diode, FD100	26006930	FSC
CR23	Diode, FD100	26006930	FSC
CR24	Diode, IN486A	26014570	FSC

Ref.	Description	SD Part No.	Manufacturers Part No.
CR25	Capacitor, fixed, 6.8µF, 6V	03280370	Sprague 150D685X9006A2
IC1	Integrated Circuit, µL910	26011160	FSC U5B991020X
IC2	Integrated Circuit, µL910	26011160	FSC U5B991020X
IC3	Integrated Circuit, µL974	26012480	U5B997429X
IC4	Integrated Circuit, µL911	26011920	U5B991129X
IC5	Integrated Circuit, µL911	26011920	U5B991129X
IC6	Integrated Circuit, µL910	26011160	FSC &5B991020X
IC7	Integrated Citcuit, µL911	26011920	U5B991129X
Q1	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q2	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q3	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q4	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q5	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q6	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q7	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q8	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q9	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q10	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q11	Transistor, 2N3563	26012050	FSC TXY1211EXX
Q12	Transistor, 2N3563	26012050	FSC TXY1211EXX
R1	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R2	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R3	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R4	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R5	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R6	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R7	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R8	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R9	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	02354770	AB
R10	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R11	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R12	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R13	Resistor, fixed, 2.2 kΩ, 5%, 1/4W	02354690	AB
R14	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R15	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R16	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R17	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R18	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R19	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R20	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R21	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R22	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R23	Resistor, fixed, 3 kΩ, 5%, 1/4W	02354720	AB
R24	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R25	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R26	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R27	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R28	Resistor, fixed, 22 kΩ, 5%, 1/4W	02354930	AB
R29	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R30	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R31	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R32	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R33	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R34	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R35	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R36	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB
R37	Resistor, fixed, 36 kΩ, 5%, 1/4W	02354980	AB

CIRCUIT DESCRIPTION
OPTION 02 (A9) AC CONVERTER
SCHEMATIC #D37405B

The AC Converter board changes ac voltage to a proportional dc voltage. The resulting dc voltage is then measured by the multimeter. To accomplish the conversion, the AC Converter board contains the following circuits: a voltage supply circuit, an attenuator circuit and an ac-to-dc conversion circuit.

Voltage Supply Circuit

A source voltage of + and -25 volts dc is fed to series pass regulators Q6 and Q7 producing the AC Converter board's + and -15 volt supplies. R38, R39, R40, and R41 provide proper bias; and C17 and C18 provide filtering.

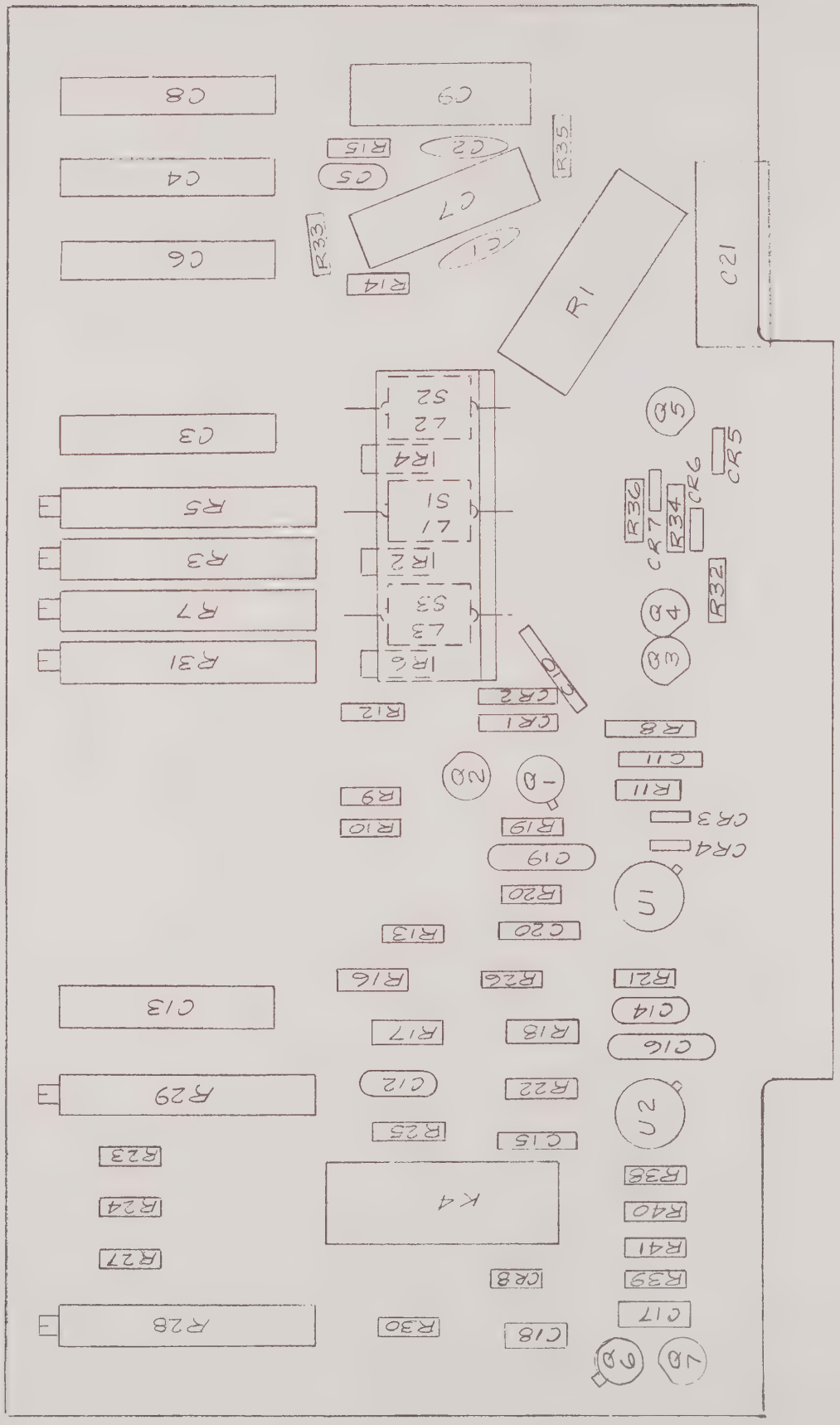
Attenuator Circuit

When ac is selected, K4 is actuated through CR8 connecting the converter output to the input terminal of the Input Amplifier (A8); and the HI input connector of the instrument is connected to the input of the AC Converter (A9). For the 10 V, 100 V, or 1000 V ranges, range control signals through diodes CR5, CR6, or CR7 turn on relay driving transistors Q3, Q4, or Q5 respectively and close switches S1, S2, or S3 through a magnetic field generated by L1, L2, or L3. When one of these switches is closed, R8 and its associated shunt capacitance is shunted by a resistor capacitor combination which increases the attenuation in the input by a factor of 10, 100, or 1000. A small variable capacitor is also added in shunt with R1 and C3 to adjust the high frequency attenuation to obtain a flat frequency response. Elements R33, R14, C1, R35, R15, and C2 are employed to compensate for the imperfection in the other elements of the attenuator.

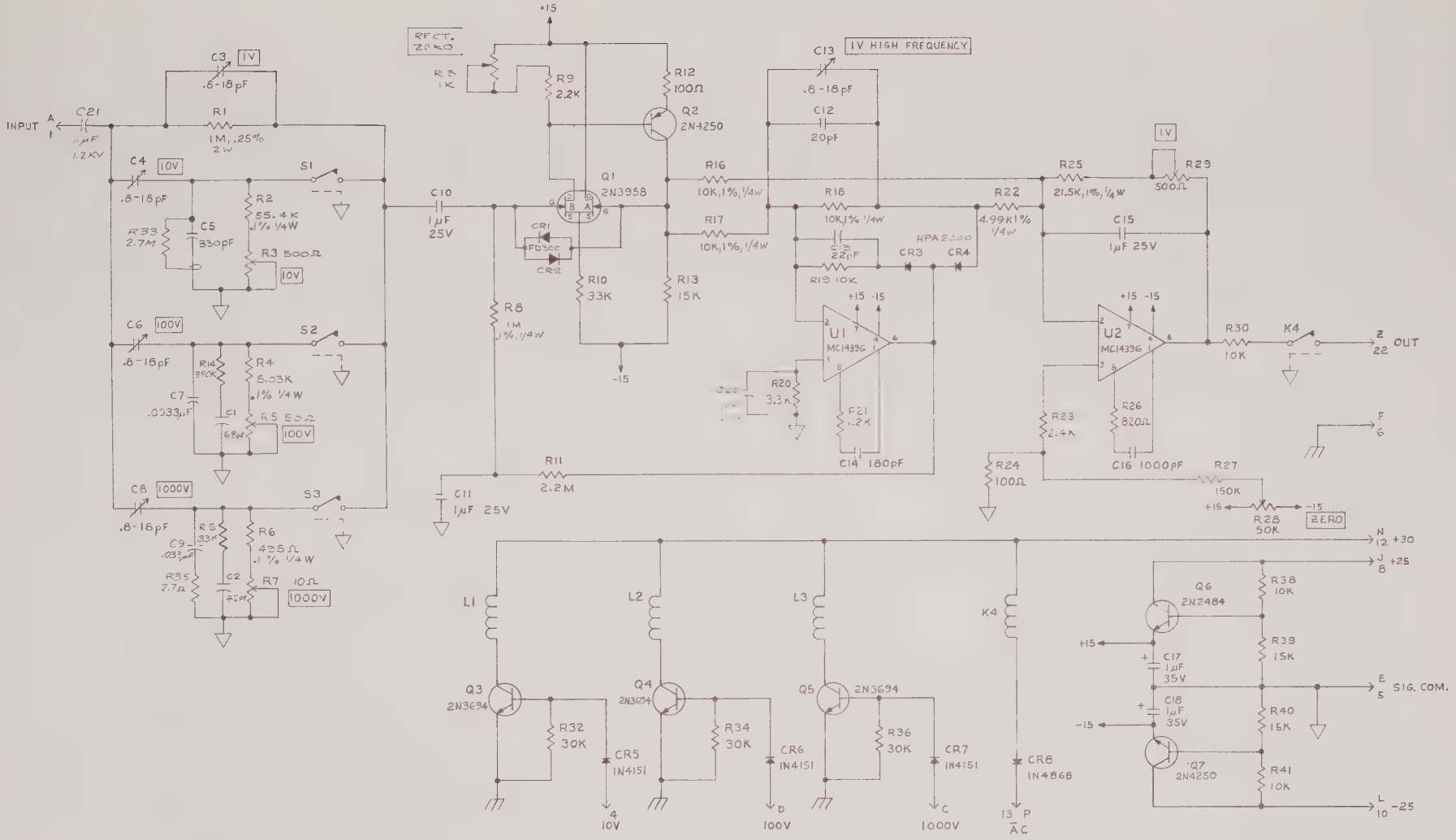
AC to DC Conversion Circuit

Q1 and Q2 comprise a unity gain amplifier with a high input impedance, a very light loading on the input attenuator, and a low output impedance for driving the following stages.

Amplifier U2 has negative feedback provided by R25, R29, and C15 with input currents through R16 and R22. The current through R16 is directly proportional to the input voltage. Amplifier U1 inverts the input signal and generates positive halfwave rectified signals at the junction of CR3, R19, and C19. The positive halfwave rectified signal results in a current through R22 to the input summing junction of U2 which is twice the value of current through R16 and opposite in sign. As a result, only positive halfwaves of current are effectively fed to U2 which amplifies the dc component and filters out much of the ac components through the action of C15. The negative dc output voltage is proportional to the fullwave average value of the input voltage and the value of R25 and R29 is adjusted so that the reading of the DMM is equal to the RMS value of a sine wave.



OPTION 02 (A9) AC CONVERTER P.C. ASSEMBLY D37402B



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE 1/4 W 5%.
2. S1, S2 & S3 ARE MR1077 20/40
3. L1, L2 & L3 ARE UM2A1
4. K1 IS 37297-4-1

OPTION 02 (A9) AC CONVERTER P.C. SCHEMATIC D37405B

OPTION 02 (A9) AC CONVERTER ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, 6.8 pF	C0849	Arco CCT06R81
C2	Capacitor, 82 pF, DM	C0535	Elmenco DM-15E-280K-500
C3	Capacitor, .8-18 pF	03289640	JFD VC32G
C4	Capacitor, .8-18 pF	03289640	JFD VC32G
C5	Capacitor, 330 pF, 500 V, DM	C0540	Elmenco DM-15F331K
C6	Capacitor, .8-18 pF	03289640	JFD VC32G
C7	Capacitor, .0033 µF, 100 V	C1260	
C8	Capacitor, .8-18 pF	03289640	JFD VC32G
C9	Capacitor, .033 µF, 100 V	C1256	
C10	Capacitor, 1 µF, 25 V	C0879	Sprague 5C023105X025033
C11	Capacitor, 1 µF, 25 V	C0879	Sprague 5C023105X025033
C12	Capacitor, 20 pF, 500 V, DM	03175100	
C13	Capacitor, .8-18 pF	03289640	JFD VC32G
C14	Capacitor, 180 pF, DM	03281380	
C15	Capacitor, 1 µF, 25 V	C0879	Sprague 5C023105X025033
C16	Capacitor, 1000 pF, 100 V, DM	C0543	Elmenco DM-15-102K-100
C17	Capacitor, 1 µF, 35 V	03282660	Sprague 150D105X9035A2
C18	Capacitor, 1 µF, 35 V	03282660	Sprague 150D105X9035A2
C19	Capacitor, 22 pF, DM	C0378	Elmenco DM15-C-220J-500
C20	Capacitor, 1 µF, 25 V	C0879	Sprague 5C023105X025033
C21	Capacitor, .1 µF, 1.2 kV	03286130	
CR1	Diode, FD300	26012320	
CR2	Diode, FD300	26012320	
CR3	Diode, HPA2900	26015360	
CR4	Diode, HPA2900	26015360	
CR5	Diode, 1N4151	CR0150	
CR6	Diode, 1N4151	CR0150	
CR7	Diode, 1N4151	CR0150	
CR8	Diode, 1N486B	26015330	
K1	Not Used		
K2	Not Used		
K3	Not Used		
K4	Reed Switch, Low Level, Low Thermal	37297-4-1	
L1	Coto Coil, UM24P	L0175	
L2	Coto Coil, UM24P	L0175	

OPTION 02 (A9) AC CONVERTER ASSEMBLY (Cont'd)

Ref.	Description	SD Part No.	Manufacturers Part No.
L3	Coto Coil, UM24P	L0175	
Q1	Transistor, 2N3958	26015100	
Q2	Transistor, 2N4250	26014430	
Q3	Transistor, 2N3694	26012660	
Q4	Transistor, 2N3694	26012660	
Q5	Transistor, 2N3694	26012660	
Q6	Transistor, 2N2484	26010670	
Q7	Transistor, 2N4250	26014430	
R1	Resistor, 1 M, 25%, 2 W, Vamistor	R2714	
R2	Resistor, 55.4 k, .1%, 1/4 W, MF	R2532	Pyrofilm PME60T9
R3	Resistor, 500 Ω, Potentiometer	01110250	
R4	Resistor, 5.03 k, .1%, 1/4 W, MF	R2530	Pyrofilm PME60T9
R5	Resistor, 50 Ω, Potentiometer	01110220	
R6	Resistor, 495 Ω, .1%. 1/4 W, MF	R2528	Pyrofilm PME60T9
R7	Resistor, 10 Ω, Potentiometer	01111280	
R8	Resistor, 1 M, .1%, 1/4 W, MF	R2533	Pyrofilm PME60T9
R9	Resistor, 2.2 k, 5%, 1/4 W, CC	R0749	AB
R10	Resistor, 33 k, 5%, 1/4 W, CC	R0780	AB
R11	Resistor, 2.2 M, 5%, 1/4 W, CC	R1014	AB
R12	Resistor, 100 Ω, 5%, 1/4 W, CC	R0966	AB
R13	Resistor, 15 k, 5%, 1/4 W, CC	R0728	AB
R14	Resistor, 390 k, 5%, 1/4 W, CC	R2420	AB
R15	Resistor, 33 k, 5%, 1/4 W, CC	R0780	AB
R16	Resistor, 10 k, 1%, 1/4 W, MF	R2455	Pyrofilm PME60T9
R17	Resistor, 10 k, 1%, 1/4 W, MF	R2455	Pyrofilm PME60T9
R18	Resistor, 10 k, 1%, 1/4 W, MF	R2455	Pyrofilm PME60T9
R19	Resistor, 10 k, 5%, 1/4 W, CC	R0766	AB
R20	Resistor, 3.3 k, 5%, 1/4 W, CC	R0742	AB
R21	Resistor, 1.2 k, 5%, 1/4 W, CC	R0809	AB
R22	Resistor, 4.99 k, 1%, 1/4 W, MF	R2677	
R23	Resistor, 2.4 k, 5%, 1/4 W, CC	R1045	AB
R24	Resistor, 100 Ω, 5%, 1/4 W, CC	R0966	AB
R25	Resistor, 21.5 k, 1%, 1/4 W, MF	R2715	
R26	Resistor, 820 Ω, 5%, 1/4 W, CC	R0762	AB

OPTION 02 (A9) AC CONVERTER ASSEMBLY (Cont'd)

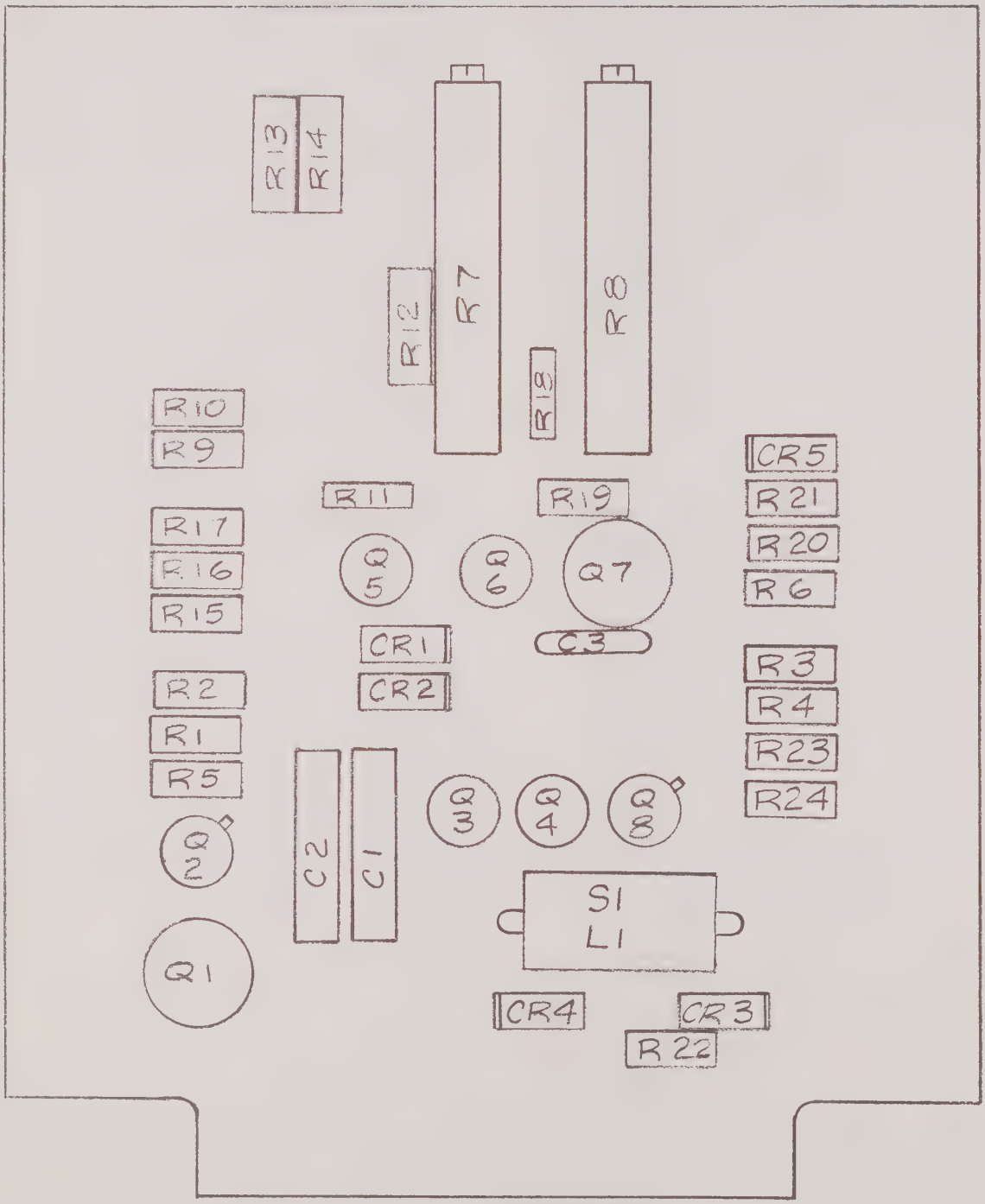
Ref.	Description	SD Part No.	Manufacturers Part No.
R27	Resistor, 150 k, 5%, 1/4 W, CC	R0762	AB
R28	Resistor, 50 k, Potentiometer	01110320	
R29	Resistor, 500Ω , Potentiometer	01110250	
R30	Resistor, 10 k, 5%, 1/4 W, CC	R0766	AB
R31	Resistor, 1 k, Potentiometer	01110260	
R32	Resistor, 30 k, 5%, 1/4 W, CC	R0715	AB
R33	Resistor, 2.7 M, 5%, 1/4 W, CC	R1020	AB
R34	Resistor, 30 k, 5%, 1/4 W, CC	R0715	AB
R35	Resistor, 2.7Ω , 5%, 1/4 W	R1697	AB
R36	Resistor, 30 k, 5%, 1/4 W, CC	R0715	AB
R37	Not Used		
R38	Resistor, 10 k, 5%, 1/4 W, CC	R0766	AB
R39	Resistor, 15 k, 5%, 1/4 W, CC	R0728	AB
R40	Resistor, 15 k, 5%, 1/4 W, CC	R0728	AB
R41	Resistor, 10 k, 5%, 1/4 W, CC	R0766	AB
S1	Switch, Gordos, MR1077, 20/40	S0400	
S2	Switch, Gordos, MR1077, 20/40	S0400	
S3	Switch, Gordos, MR1077, 20/40	S0400	

CIRCUIT DESCRIPTION
OPTION 03 (A10) OHMS CONVERTER
SCHEMATIC #D39227B

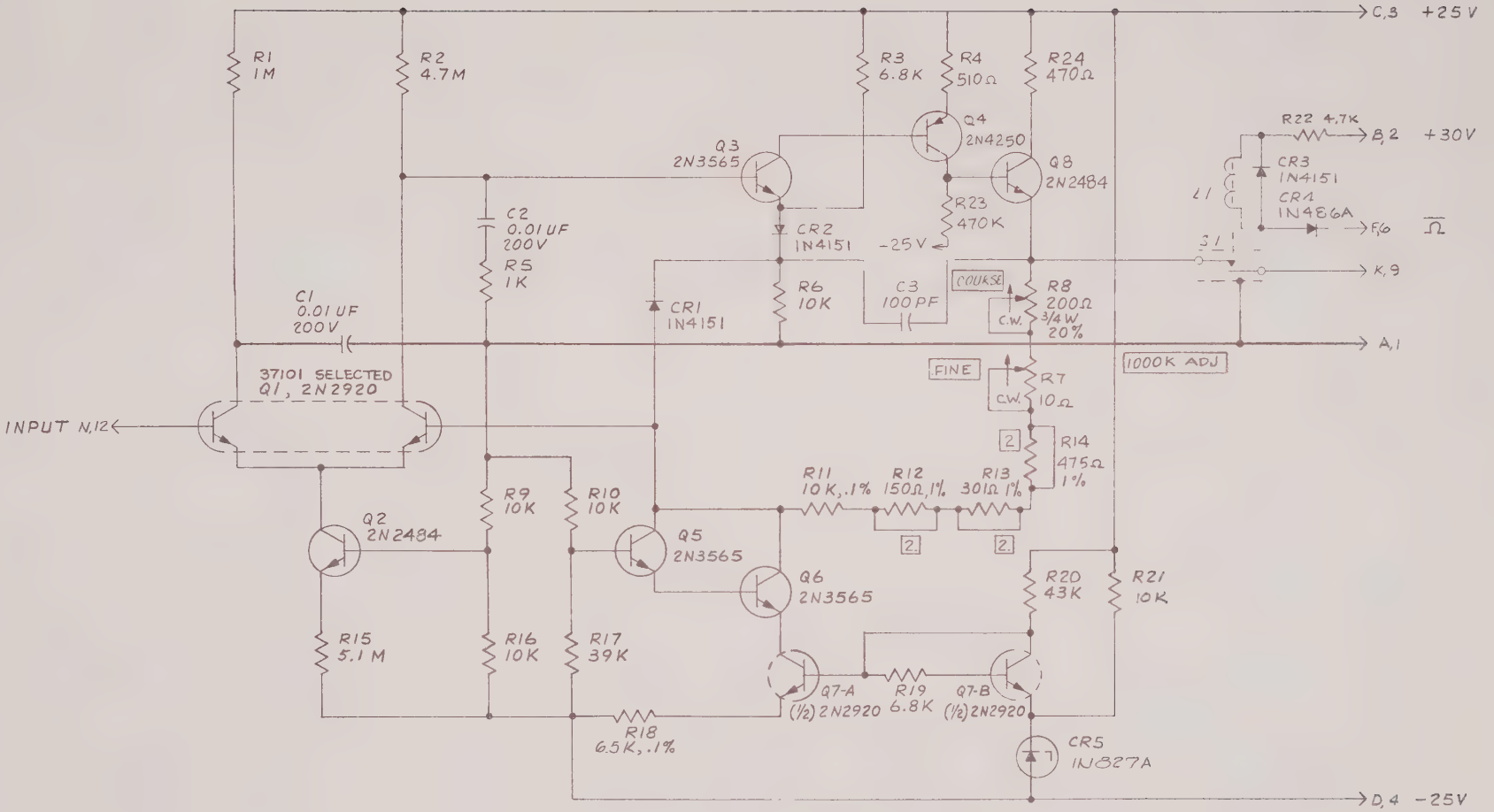
Resistance is measured by programming a constant current through the unknown resistance and measuring the resulting voltage drop with the basic DC measurement system. Relay A10K1 is closed by the function logic when the kΩ mode is selected. A feedback circuit consisting of bootstrap amplifier A10 and ranging resistors programmed by relays A8K1, A8K2, A8K3, and A8K4 acts as a constant current generator to supply a test current of .1 μA, 1 μA, 100 μA or 1 mA. The bootstrap amplifier output is equal to the voltage at the summing junction (input of amplifier A7) plus 10 V. This maintains 10 V across the current programming resistance. The test current through the unknown resistance is therefore 10 V/R_{Range}. The DC voltage appearing at the input of amplifier A7 is proportional to the value of unknown resistance. By suitable switching of range resistors on A8 and the transconductance resistor on A7, five ranges of resistance readout can be obtained.

Ohms Converter

The ohms converter is a bootstrap amplifier which provides an output voltage equal to its input voltage plus 10 V. Transistors A10Q1A and A10Q1B comprise a differential amplifier with A10Q3, A10Q4, and A10Q8 acting as following stages. The base of A10Q1A is tied to the floating ground on input amplifier A7 and the base of A10Q1B is connected to an approximately 1 mA constant current generator. A feedback resistance of 10 kΩ (A10R11, R12, R13, R14, R7, and R8) is connected between the output and the inverting input (base of A10Q1B). This bootstrap configuration maintains 10 V across the feedback resistance holding the amplifier output voltage equal to the voltage level at the input plus 10 V. The constant current generator comprises A10Q5, A10Q6, A10Q7, and A10CR5. Zener diode CR5 provides a reference voltage of 6.2 V. This voltage is maintained across A10R18, causing a constant current of about 1 mA to flow in the collector circuit of A10Q7A. Feedback between the output and input is via resistors A10R14, A10R13, A10R12, A10R11 and potentiometers A10R7 and A10R8. The shorting links across A10R12, A10R13, and A10R14 may be removed for coarse adjustment, and A10R8 and A10R7 allow for fine adjustment.



OPTION 03 (A10) OHMS CONVERTER P.C. ASSEMBLY C3923OE



OPTION 03 (A10) OHMS CONVERTER SCHEMATIC D39227B

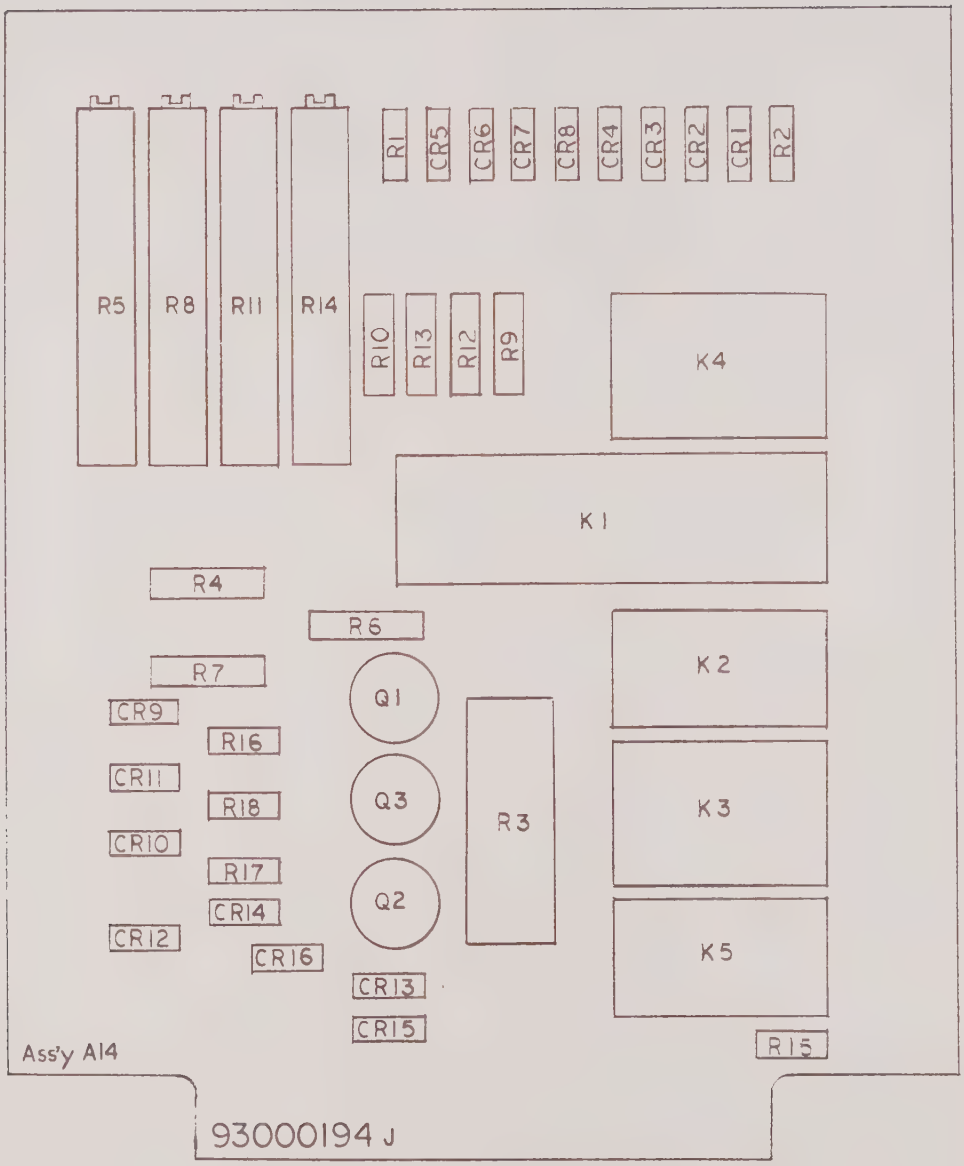
OPTION 03 (A10) OHMS CONVERTER ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, .01μF, 200V	03278910	TRW 663F10392W2
C2	Capacitor, fixed, .01μF, 200V	03278910	TRW 663F10392W2
C3	Capacitor, fixed, 100μF, 500V	03281320	Elmenco DM15-101J
CR1	Diode, IN4151	CR0150	
CR2	Diode, IN4151	CR0150	
CR3	Diode, IN4151	CR0150	
CR4	Diode, IN486A	26014570	FSC
CR5	Diode, IN827	26013960	FSC
L1	Coil, Reed Relay	21103130	Coto U32P
Q1	Transistor, Selected	37101	SD
Q2	Transistor, 2N2484	26010670	FSC TXB1250HBX
Q3	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q4	Transistor, 2N4250	26014430	FSC TXY0019ELA
Q5	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q6	Transistor, 2N3565	26012000	FSC TXY1250EBX
Q7	Transistor, 2N2920	26011350	FSC FAA1250HA1
Q8	Transistor, 2N2484	26010670	
R1	Resistor, fixed, 1MΩ, 5%, 1/4W	02355330	AB
R2	Resistor, fixed, 4.7MΩ, 5%, 1/4W	02355490	AB
R3	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R4	Resistor, fixed, 510Ω, 5%, 1/4W	02354550	AB
R5	Resistor, fixed, 1 kΩ, 5%, 1/4W	02354620	AB
R6	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R7	Resistor, 10Ω, Potentiometer	01110200	AB
R8	Resistor, variable, 200Ω, 3/4W	01110240	Beckman 78PR200
R9	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R10	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R11	Resistor, fixed, 10 kΩ, .1%, 3W	02398660	Vishay S102
R12	Resistor, fixed, 150Ω, 1%, 1/10W	02394760	Dale RN55D
R13	Resistor, fixed, 301Ω, 1%, 1/10W	02394770	Dale RN55C
R14	Resistor, fixed, 475Ω, 1%, 1/10W	02394750	Dale RN55D
R15	Resistor, fixed, 5.1MΩ, 5%, 1/4W	02355500	AB
R16	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R17	Resistor, fixed, 39 kΩ, 5%, 1/4W	02354990	AB
R18	Resistor, fixed, 6.5 kΩ, .1%, .3W	02403000	Vishay S102
R19	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R20	Resistor, fixed, 43k, 5%, 1/4W	02355000	AB

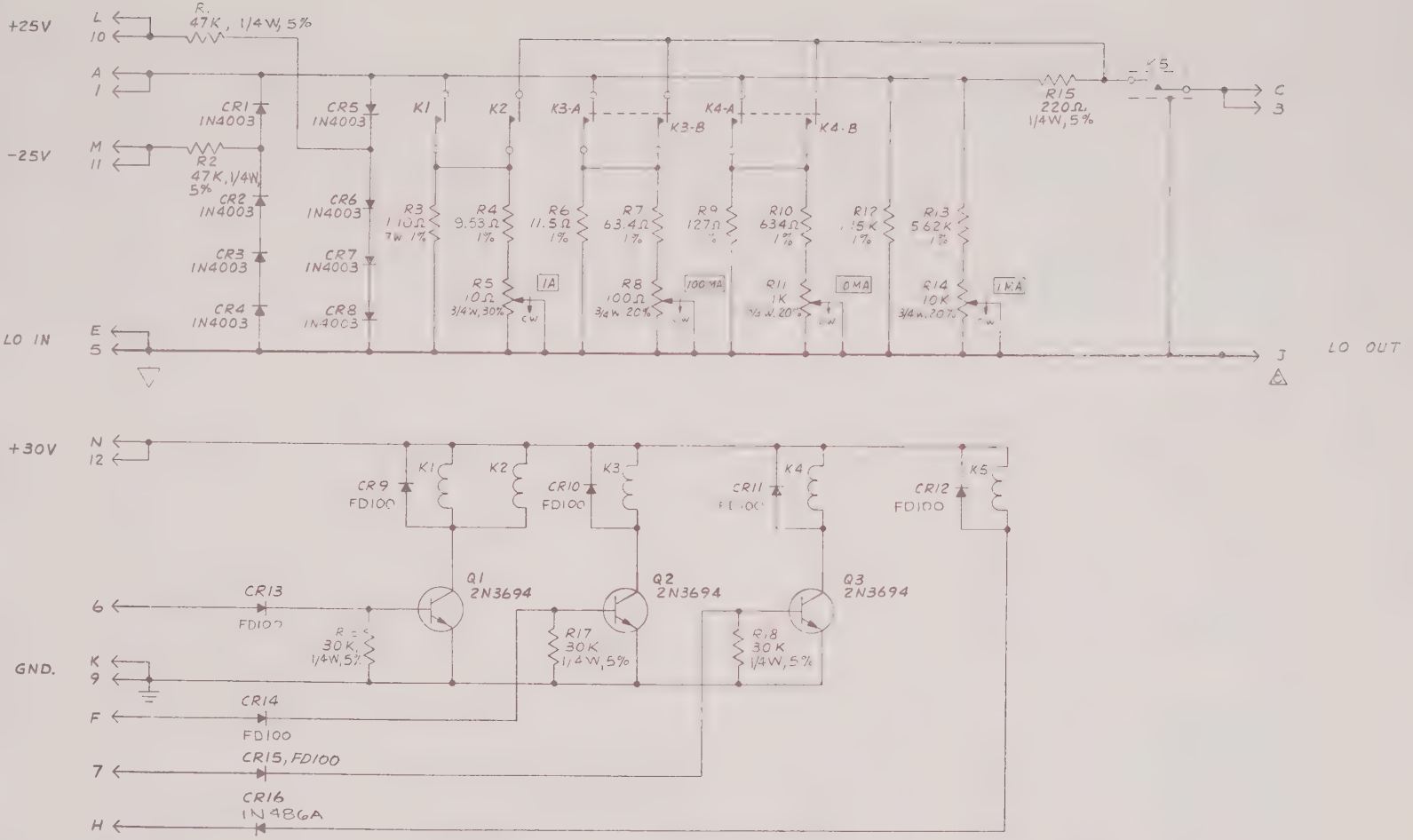
Ref.	Description	SD Part No.	Manufacturers Part No.
R21	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R22	Resistor, fixed, 4.7 kΩ, 5%, 1/4W	R0892	AB
S1	Switch, reed	05036220	Hamlin MRMF-2
	Shield, reed relay	42025811	SD

CIRCUIT DESCRIPTION
OPTION 04 (A14) DC CURRENT MEASUREMENT
SCHEMATIC #D93000194J

Direct current is measured by monitoring the voltage drop created when the unknown current flows through precision shunt resistors mounted on A14. The voltage drop is monitored with the basic DC measuring circuitry. Relays A7K1 and A14K5 are energized by the function logic when the MA mode is selected by the front panel FUNCTION switch. In each range, shunt resistances are selected to give a full scale input of 1 V to the DC circuit. The relay circuit connecting the shunts into the circuit employs a 4-point Kelvin configuration with voltage sensing whereby the voltage drop across the shunt relay and associated wiring does not contribute to the measurement and cause a readout error. This feature is especially significant when performing high current measurements. Diodes A14CR1 through A14CR8 form a clamp to protect the instrument from excessive voltages applies at the input.



OPTION 04 (A14) CURRENT SHUNT P.C. ASSEMBLY C93000194J



OPTION 04 (A14) CURRENT SHUNT SCHEMATIC D9300194J

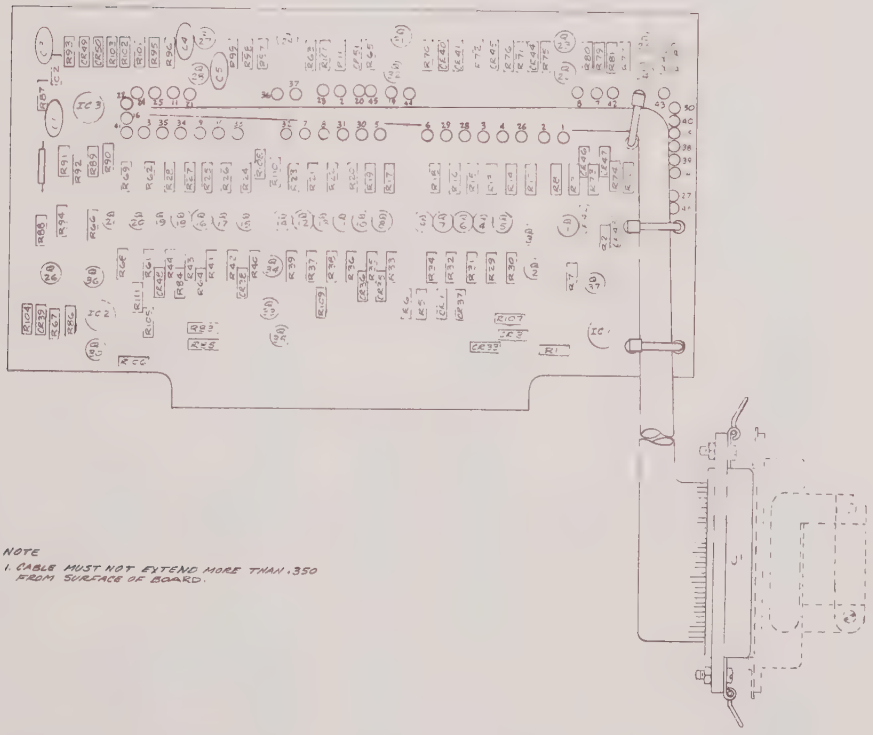
A14 CURRENT SHUNT ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
CR1	Diode, IN4003	26011080	FSC
CR2	Diode, IN4003	26011080	FSC
CR3	Diode, IN4003	26011080	FSC
CR4	Diode, IN4003	26011080	FSC
CR5	Diode, IN4003	26011080	FSC
CR6	Diode, IN4003	26011080	FSC
CR7	Diode, IN4003	26011080	FSC
CR8	Diode, IN4003	26011080	FSC
CR9	Diode, FD100	26006930	FSC DXA1100801
CR10	Diode, FD100	26006930	FSC DXA1100801
CR11	Diode, FD100	26006930	FSC DXA1100801
CR12	Diode, FD100	26006930	FSC DXA1100801
CR13	Diode, FD100	26006930	FSC DXA1100801
CR14	Diode, FD100	26006930	FSC DXA1100801
CR15	Diode, FD100	26006930	FSC DXA1100801
CR16	Diode, IN486A	26014570	FSC
K1	Reed Switch	05036870	Gordos MR-893
K2	Reed Switch	05036220	SD
K3	Reed Switch	05036220	SD
K4	Reed Switch	05036220	SD
K5	Reed Switch	05036220	SD
LK1	Coil, reed relay	21103060	Coto SP24P
LK2	Coil, reed relay	21103130	Coto U32P
LK3	Coil, reed relay	21103070	Coto UD32P
LK4	Coil, reed relay	21103070	Coto UD32P
LK5	Coil, reed relay	21103130	Coto U32P
Q1	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q2	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q3	Transistor, 2N3694	26012660	FSC TXY1243EBX
R1	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R2	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R3	Resistor, fixed, WW, 1.10Ω, 1%, 7W	02401070	Dale AGS-10
R4	Resistor, fixed, 9.53Ω, 1%, 1/4W	02393980	Dale RS-1/4
R5	Resistor, variable, 10Ω, 22-turn	01110200	Beckman 78PR10
R6	Resistor, fixed, 11.5Ω, 1/%, 1/8W	02398480	Dale 6710
R7	Resistor, fixed, 63.4Ω, 1%, 1/8W	02399410	Dale RN60C Ser.
R8	Resistor, variable, 100Ω, 10-turn	01110230	Beckman 78PR10D

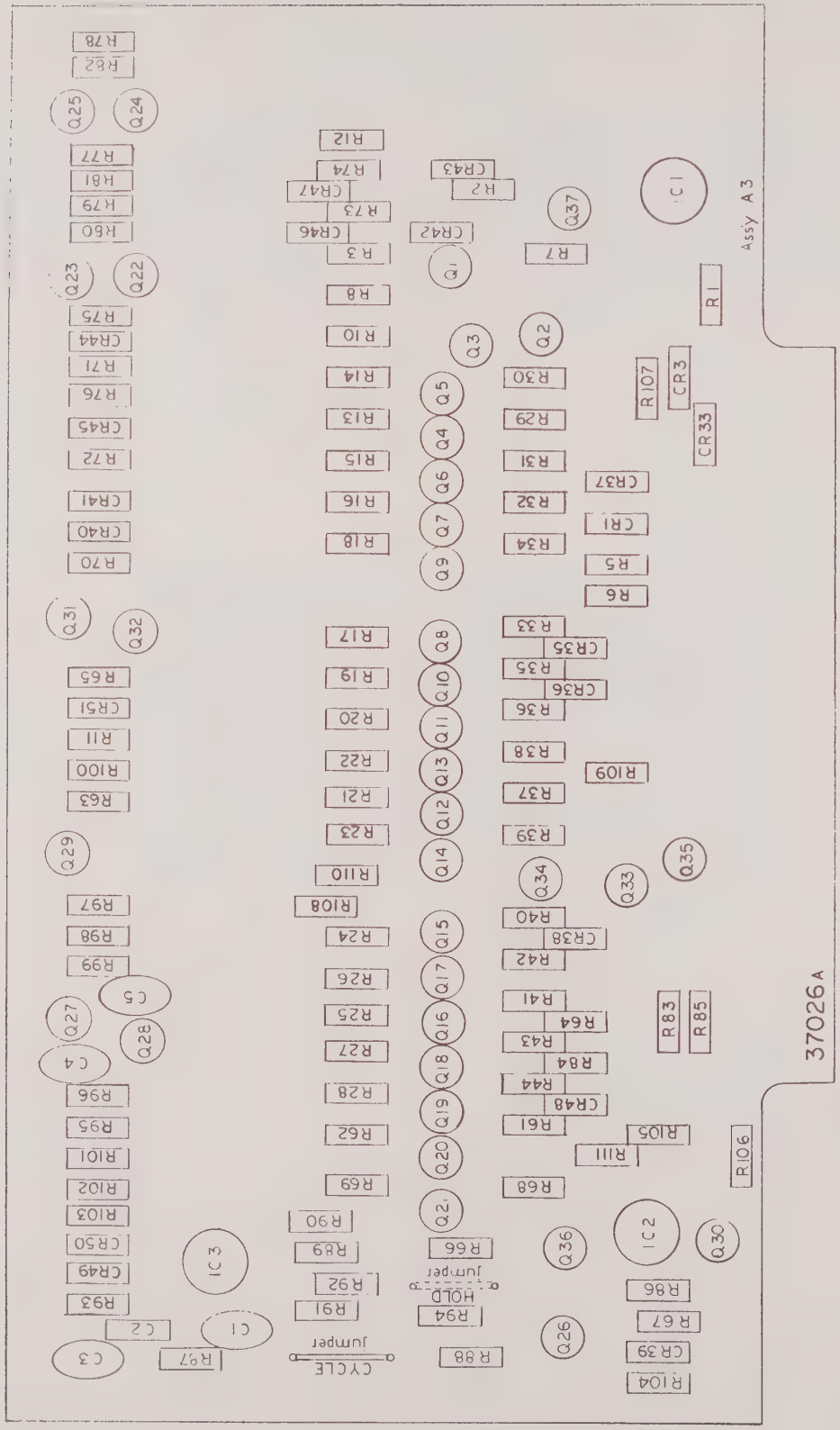
Ref.	Description	SD Part No.	Manufacturers Part No.
R9	Resistor, fixed, 127Ω, 1%, 1/8W	02398500	Dale RN60C Ser.
R10	Resistor, fixed, 634Ω, 1%, 1/8W	02398540	Dale RN60C Ser.
R11	Resistor, variable, 1 kΩ, 10-turn	01110260	Spectrol 530
R12	Resistor, fixed, 1.15 kΩ, 1%, 1/8W	02399420	Dale RN60C Ser.
R13	Resistor, fixed, 5.62 kΩ, 1%, 1/8W	02399400	Dale RN60C Ser.
R14	Resistor, variable, 10 kΩ, 10-turn	01110290	Beckman 78PR
R15	Resistor, fixed, 220Ω, 5%, 1/4W	02354460	AB
R16	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R17	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
R18	Resistor, fixed, 30 kΩ, 5%, 1/4W	02354960	AB
	Shield, reed relay	42025811	SD

CIRCUIT DESCRIPTION
BCD OPTION ASSEMBLY 05
SCHEMATIC #D37023A

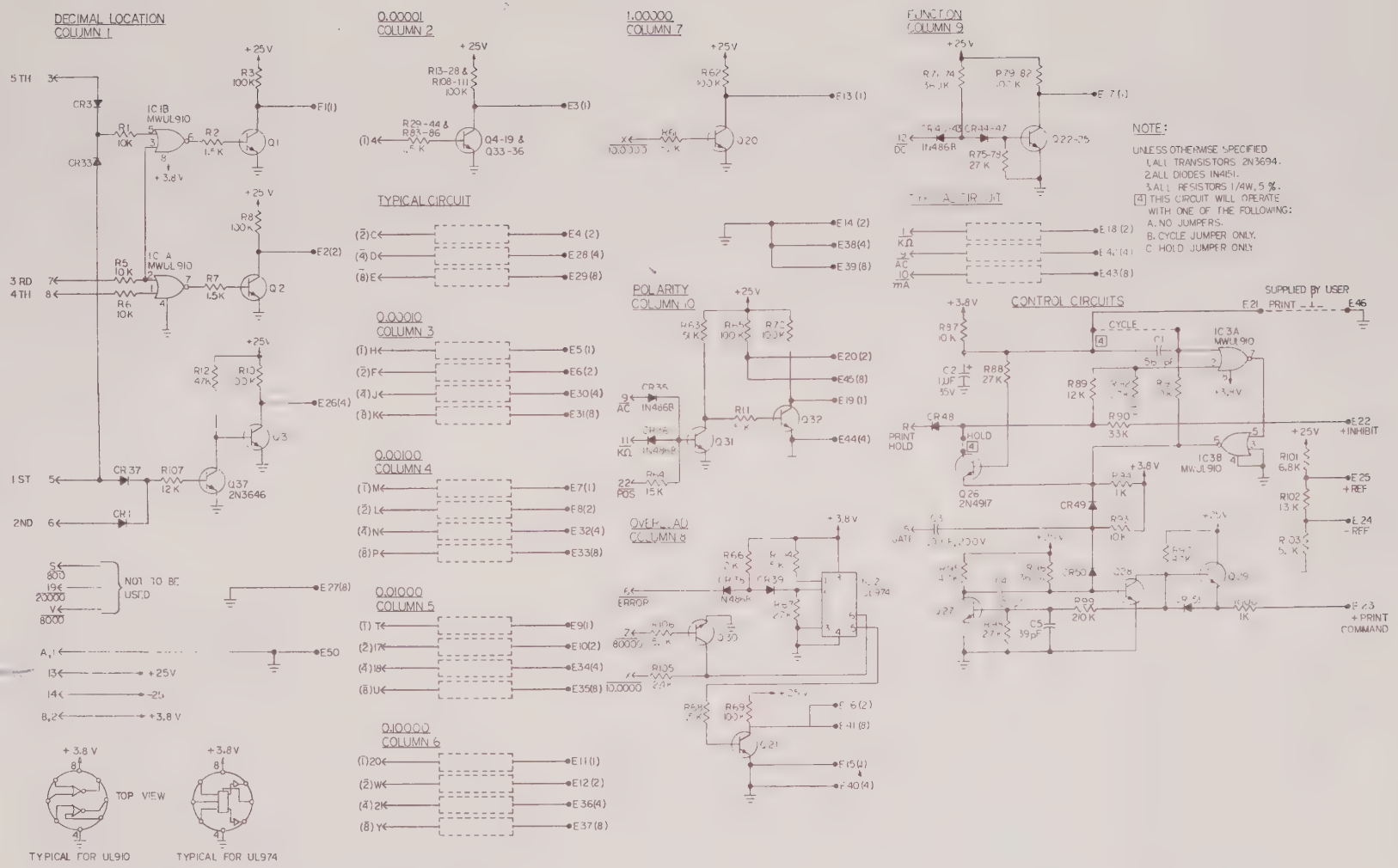
BCD Option 05 serves as a signal conditioner for the Fairchild $C_{\mu}L959$ integrated circuit storage elements, changing their outputs to a level suitable for printer application. Output is a common emitter transistor to ground with 100 kΩ pull up to +25V. Option 05 also performs the necessary logic functions required for proper operation of the printer. See Page 2-3.



NOTE
1. CABLE MUST NOT EXTEND MORE THAN .350 FROM SURFACE OF BOARD.



BCD OPTION P.C. BOARD D37026A



05 BCD OPTION SCHEMATIC D37023A

OPTION 05 (A3) BCD ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, fixed, 560pF, 300V	03281520	Elmenco DM15-561J
C2	Capacitor, fixed, 1µF, 35V	03279130	Sprague
C3	Capacitor, fixed, .01µF, 200V	03286710	Westcap 4M103
C4	Capacitor, fixed, 820pF, 300V	03281560	Elmenco DM15-821J
C5	Capacitor, fixed, 29pF, 500V	03175170	Elmenco DM15-390J
CR1	Diode, IN4151	CR0150	FSC
CR2	Not Used		
CR3	Diode, IN4151	CR0150	FSC
CR4 Thru CR34	Not Used		
CR35	Diode, IN486B	26015330	FSC
CR36	Diode, IN486B	26015330	FSC
CR37	Diode, IN4151	CR0150	FSC
CR38	Diode, IN486B	25015330	FSC
CR39	Diode, IN4151	CR0150	FSC
CR40	Diode, IN486B	26015330	FSC
CR41	Diode, IN486B	26015330	FSC
CR42	Diode, IN486B	26015330	FSC
CR43	Diode, IN486B	26015330	FSC
CR44	Diode, IN4151	CR0150	FSC
CR45	Diode, IN4151	CR0150	FSC
CR46	Diode, IN4151	CR0150	FSC
CR47	Diode, IN4151	CR0150	FSC
CR48	Diode, IN4151	CR0150	FSC
CR49	Diode, IN4151	CR0150	FSC
CR50	Diode, IN4151	CR0150	FSC
CR51	Diode, IN4151	CR0150	FSC
IC1	Integrated Circuit, Lµ910	26011160	FSC U5B991029X
IC2	Integrated Circuit, Lµ914	26012480	FSC U5B991429X
IC3	Integrated Circuit, L910	26011160	FSC U5B991029X
Q1	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q2	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q3	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q4	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q5	Transistor, 2N3694	26012660	FSC TXY1243EBX

Ref.	Description	SD Part No.	Manufacturers Part No.
Q6	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q7	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q8	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q9	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q10	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q11	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q12	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q13	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q14	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q15	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q16	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q17	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q18	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q19	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q20	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q21	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q22	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q23	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q24	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q25	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q26	Transistor, 2N4917	26014620	FSC
Q27	Transistor, 2N3694	26012660	FSC TYX1243EBX
Q28	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q29	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q30	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q31	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q32	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q33	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q34	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q35	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q36	Transistor, 2N3694	26012660	FSC TXY1243EBX
Q37	Transistor, 2N3646	Q0218	FSC TXY0062EMB
R1	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R2	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R3	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R4	Not Used		
R5	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB

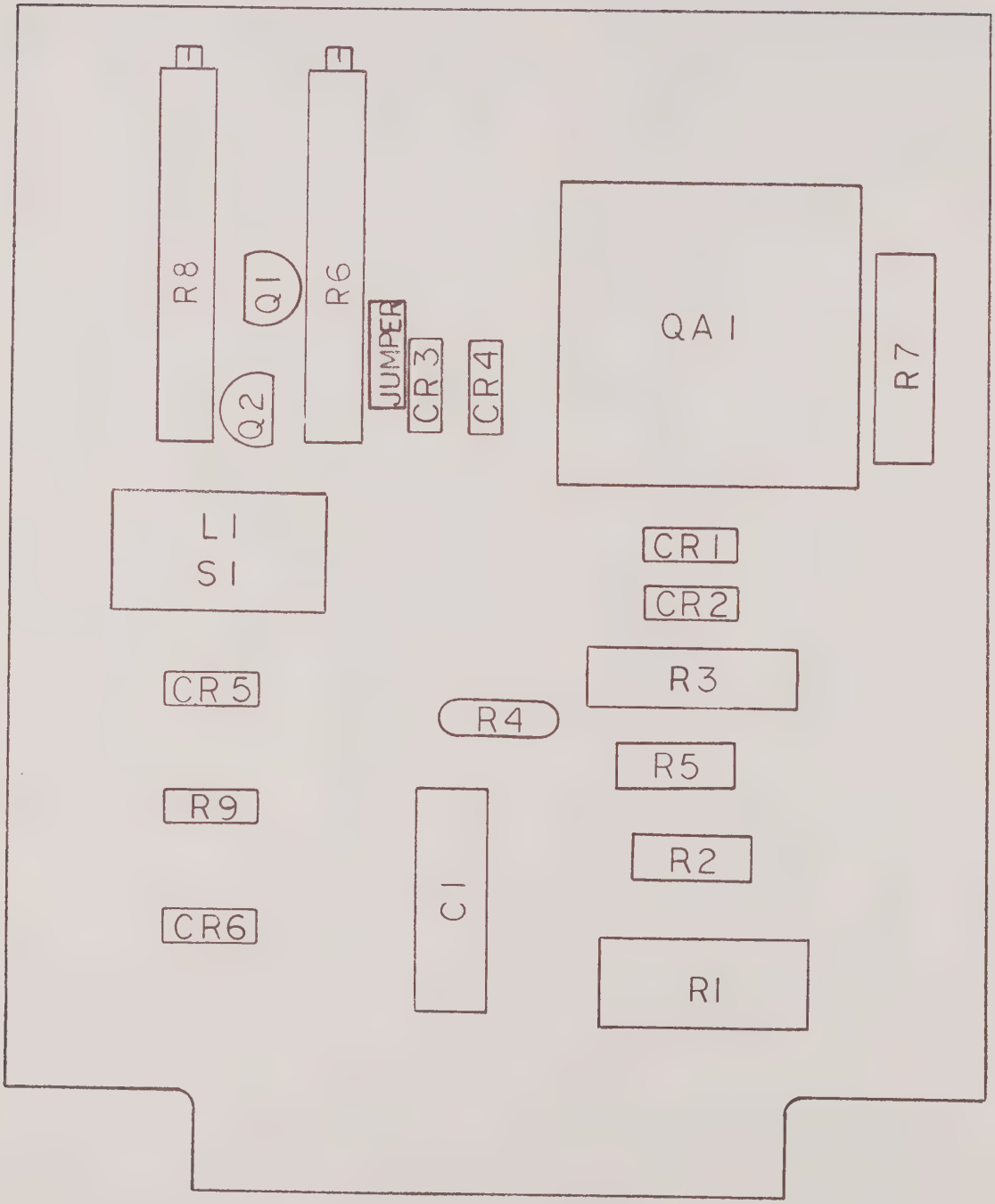
Ref.	Description	SD Part No.	Manufacturers Part No.
R6	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R7	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R8	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R9	Not Used		
R10	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R11	Resistor, fixed, 51 kΩ, 5%, 1/4W	R0842	AB
R12	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R13	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R14	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R15	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R16	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R17	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R18	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R19	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R20	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R21	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R22	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R23	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R24	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R25	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R26	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R27	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R28	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R29	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R30	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R31	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R32	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R33	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R34	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R35	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R36	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R37	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R38	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R39	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R40	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R41	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R42	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB

Ref.	Description	SD Part No.	Manufacturers Part No.
R43	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R44	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R45	Not Used		
Thru			
R60	Not Used		
R61	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R62	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R63	Resistor, fixed, 51 kΩ, 5%, 1/4W	R0842	AB
R64	Resistor, fixed, 15 kΩ, 5%, 1/4W	02354890	AB
R65	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R66	Resistor, fixed, 2 kΩ, 5%, 1/4W	02354680	AB
R67	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R68	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354650	AB
R69	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R70	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R71	Resistor, fixed, 360 kΩ, 5%, 1/4W	02355220	AB
R72	Resistor, fixed, 360 kΩ, 5%, 1/4W	02355220	AB
R73	Resistor, fixed, 360 kΩ, 5%, 1/4W	02355220	AB
R74	Resistor, fixed, 360 kΩ, 5%, 1/4W	02355220	AB
R75	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R76	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R77	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R78	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R79	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R80	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R81	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R82	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R83	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354780	AB
R84	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354780	AB
R85	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354780	AB
R86	Resistor, fixed, 1.5 kΩ, 5%, 1/4W	02354780	AB
R87	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R88	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R89	Resistor, fixed, 12 kΩ, 5%, 1/4W	02354870	AB
R90	Resistor, fixed, 33 kΩ, 5%, 1/4W	02354970	AB
R91	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R92	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB

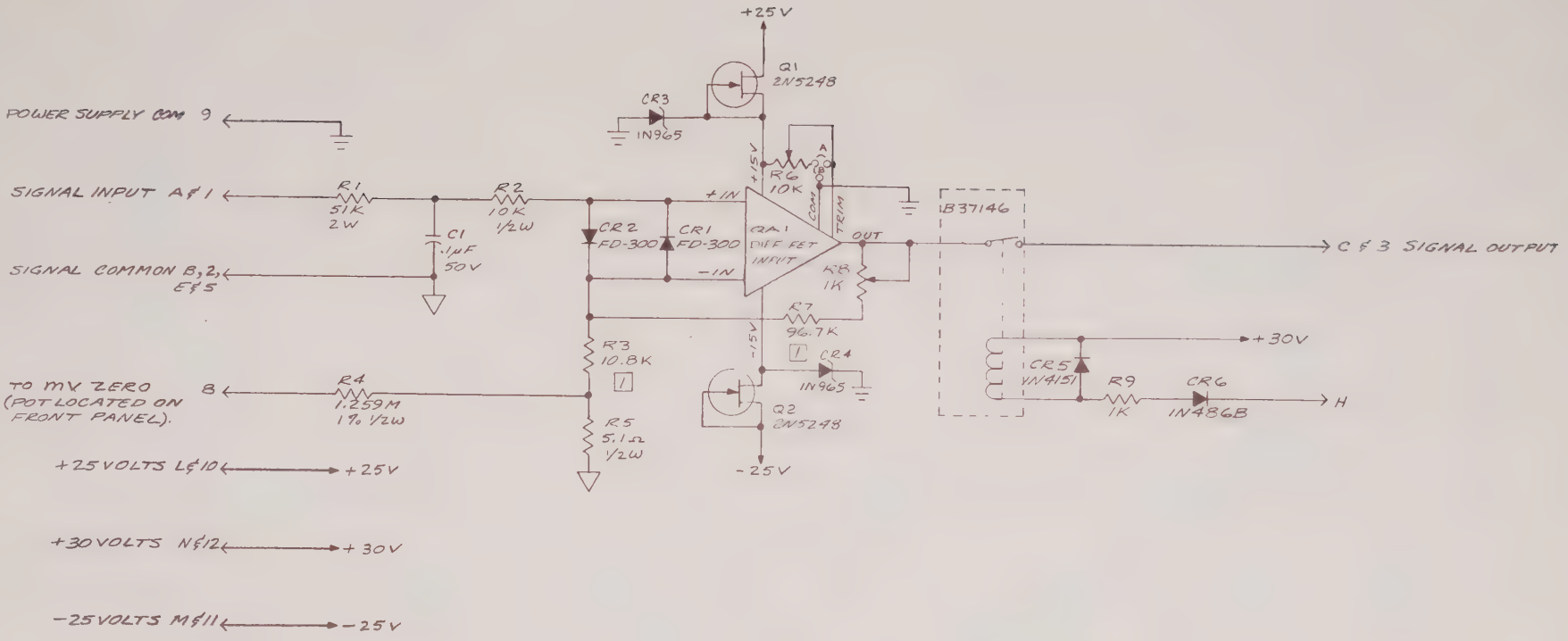
Ref.	Description	SD Part No.	Manufacturers Part No.
R93	Resistor, fixed, 10 kΩ, 5%, 1/4W	02354850	AB
R94	Resistor, fixed, 1 kΩ, 5%, 1/4W	02354620	AB
R95	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R96	Resistor, fixed, 360 kΩ, 5%, 1/4W	02355220	AB
R97	Resistor, fixed, 47 kΩ, 5%, 1/4W	02355010	AB
R98	Resistor, fixed, 27 kΩ, 5%, 1/4W	02354950	AB
R99	Resistor, fixed, 270 kΩ, 5%, 1/4W	02355190	AB
R100	Resistor, fixed, 1 kΩ, 5%, 1/4W	02354620	AB
R101	Resistor, fixed, 6.8 kΩ, 5%, 1/4W	02354810	AB
R102	Resistor, fixed, 13 kΩ, 5%, 1/4W	02354880	AB
R103	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R104	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R105	Resistor, fixed, 2.4 kΩ, 5%, 1/4W	02354700	AB
R106	Resistor, fixed, 5.1 kΩ, 5%, 1/4W	02354780	AB
R107	Resistor, fixed, 12 kΩ, 5%, 1/4W	02354870	AB
R108	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R109	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R110	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
R111	Resistor, fixed, 100 kΩ, 5%, 1/4W	02355090	AB
J1	Connector, 50 pin	09062870	Amphenol

CIRCUIT DESCRIPTION
OPTION 07 (A15) PREAMPLIFIER
SCHEMATIC #C37147B

The preamplifier is a DC amplifier with a gain of ten for the 100 mV range. The circuit uses a FET input operational amplifier in the non-inverting configuration for high input impedance, and includes ±15V power regulators, protection circuitry, and provisions for gain and offset adjustment. The feedback network is R3, R7 and R8.



OPTION 07 (A15) PREAMPLIFIER P.C. ASSEMBLY C37359C



NOTE

1. RESISTORS ARE ESI-R3 150.5 1%, ±5ppm/°C
   JEFFERS-R 7 150.2 1%, ±5ppm/°C
2. UNLESS OTHERWISE SPECIFIED RESISTORS ARE 1/4W, 5%
3. QA1 - INTECH A1026 DIFF. FET. INPUT OP. AMP.

OPTION 07 (A15) PREAMPLIFIER SCHEMATIC C37147B

OPTION 07 (A15) PREAMPLIFIER ASSEMBLY

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, 0.1µF, 50V	03284430	Elpac PD5A104
CR1	Diode, FD300	26012320	FSC
CR2	Diode, FD300	26012320	FSC
CR3	Diode, IN965	CR0153	FSC
CR4	Diode, IN965	CR0153	FSC
CR5	Diode, IN4151	CR0150	FSC
CR6	Diode, IN486B	26015330	FSC
L1/S1	Reed Switch Assembly	37146	SD
Q1	Transistor, 2N5248	Q0244	FSC
Q2	Transistor, 2N5248	Q0244	FSC
QA1	Amplifier	37356	
R1	Resistor, 51 kΩ, 5%, 2W	02036890	
R2	Resistor, 10 kΩ, 5%, 1/2W	02030720	AB
R3	Resistor, 10.8k, 0.5%, ±5 ppm ɔm/°C	02392201	
R4	Resistor, 1.259 MΩ, 1%, 1/2W	R2017	Electra MF6C0D01.259M
R5	Resistor, 5.1Ω, 5%, 1/2W	R2634	
R6	Resistor, 10 kΩ, variable	R2385	Beckman 78PR10K
R7	Resistor, 96.7k, 0.2%, ±5 ppm	R2633	ESI
R8	Resistor, 1k, variable	01110260	
R9	Resistor, 1k, 5%, 1/4W	R0765	AB

ADD ITEM 5 TO J1 MOUNTING SCREW.
#3 FROM REAR PANEL WHITE BINDING POST &
#2 FROM FRONT PANEL TERMINATE AT
SOLDER LUG ON J1

TIE ITEM 1 TO EXISTING BROWN CABLE
UNDER MOTHER BOARD, 3 PLACES.

1. REMOVE 3 SNAP BUTTONS FROM REAR PANEL.
2. ADD 08 WIRES TO EXISTING WIRES ON FRONT PANEL.

OPTION 08 REAR SIGNAL INPUT ASSEMBLY C33988A

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